Universidade de Aveiro Departamento de Ambiente e Ordenamento

2018

Daniel Pinto da Costa

Economia circular da água e planeamento do território – barreiras e desafios no contexto português

Water circular economy and spatial planning – barriers and challenges in the portuguese context

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Dissertação apresentada à Universidade de Aveiro para cumprir os requisitos necessários para adquirir o grau de Mestre em Engenharia do Ambiente, realizada sobre orientação da Doutora Teresa Fidélis, professora auxiliar no Departamento de Ambiente e Ordenamento da Universidade de Aveiro.

Dedico este trabalho aos meus pais por todo o apoio incondicional e por serem os grandes pilares da minha vida, sem eles nunca teria chegado até aqui.

O júri

presidente	Prof.ª Doutora Maria Helena Gomes de Almeida Gonçalves Nadais professora auxiliar no Departamento de Ambiente e Ordenamento da Universidade de Aveiro
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agradecimentos

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Palavras-chave

Água, economia circular, circularidade, governação, planeamento do território, planos nacionais, uso do solo

Resumo

O presente trabalho propõe-se a analisar a transição para uma economia circular em Portugal, em particular no setor da água e a sua relação com o planeamento do território, com especial foco nas barreiras e nas forças motrizes inerentes ao processo. Para esse objetivo foi realizada a análise a um conjunto de planos nacionais para a economia circular de vários países, para além de uma série de contactos diretos com especialistas nas áreas identificadas como mais relevantes. Os resultados obtidos indicam que a legislação pode ser tanto uma força motriz como uma barreira, enquanto que fatores económicos, a segregação, a mentalidade e a tecnologia são as restantes barreiras e a inovação e o planeamento do território as forças motrizes.

keywords

Circular economy, circularity, governance, land use, national plans, spatial planning, territory, water

abstract

The present essay intends to analyse the transition to a circular economy for Portugal, with particular interest to the water sector and its relation to spatial planning, with special focus on the drivers and barriers intrinsic to the process. To achieve that objective a set of national plans for circular economy was analysed, combined with direct contact with experts from the fields identified as most relevant. The results obtained indicate that legislation can be both a driver and a barrier, while economic factors, segregation, mentality and technology are the remaining barriers and innovation and spatial planning the drivers.

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1 INTRODUCTION

The subject "circular economy" does not have a defined origin, however since the 70's this concept has received an ever-increasing focus from the academics and innovative entities at first, with the topic being widespread even among the general population currently. Since it was first mentioned in the 70's the concept developed and through the years originated new schools of thought, with the ones getting a significant role being the following (Ellen MacArthur Foundation n.d.):

- Cradle to Cradle
- Performance Economy
- Biomimicry
- Industrial Ecology
- Natural Capitalism
- Blue Economy
- Regenerative Design

Addressing the "*Cradle to Cradle"* school of thought more in depth, since it is the most widespread concept of them all, it's possible to say that it consists, essentially, on eliminating the concept of waste and approaching every step of any given process in the most efficient way possible. This idea can be implemented in many ways, and for a start, having the conscience that all materials used are nutrients, either biological or technical, can be of great help (Ellen MacArthur Foundation n.d.). Just like the nutrients consumed through food by all living beings, industrial nutrients are used in the process of making any given product, and even if they are not all consumed by one industry, the leftovers, rejects or products reaching their end of life can be consumed somewhere else by other industries, just like the living counterparts. It's important to mention that although this process is a huge step in the extension of products life cycle and overall increased efficiency of material use, it cannot be applied consistently to all products since some of them aren't prepared to be reused or there isn't a way to do it efficiently, whether by the complex design, the type of material used or other difficulties (e.g. civil construction) (European Environment Agency 2017).

The current economic model employed worldwide consists on a linear process that starts with the extraction of resources (from air, water and soils), then the transformation of those resources into

products and finally the end-of-life disposal. However, since most of the existing resources are not infinite it is necessary to look for alternatives to this model that can improve the efficiency of material and resource use overall with the goal to make human existence sustainable for the planet (McKinsey 2014). For that reason the need for change is evident and that's where the circular economy model can show its worth, as a response to three major concerns of present society: ever-growing need for raw materials; the dependence on other countries and environmental sustainability (Dutch Ministry of Infrastructure and the Environment & Ministry of Economic Affairs 2016).

However, to achieve this goal of a circular economy, a considerable effort is required from all the stakeholders, and for this matter the role of regional and local authorities in the promotion and acceleration of the concept is of the utmost importance, and by paving the way and supporting the stakeholders the transition becomes a lot smoother (ESPON 2016).

1.1 General and specific goals

Circular economy is a growing topic worldwide but with so many areas of interest to the subject there is still much to develop. This dissertation aims to explore the relation between circular economy, water and spatial planning, specially the interactions between the last two in the Portuguese context. By the end of this dissertation the following questions should have been answered:

- What are the main barriers for the transition to a water circular economy in Portugal? And the main drivers?
- Which are the main actors for the transition to a circular economy in Portugal?
- In what ways can spatial planning foster and also hinder the transition to a water circular economy?
- How does Portugal compare to other European countries regarding the transition to a circular economy, more specifically related to water?

1.2 Methodological approach

The first stage consisted on a "state of the art" review concerning circular economy and its relation with water and spatial planning. This step comprised the analysis of scientific articles screened from the "Web of Science" and "Scopus" database, and also relevant documents from renowned sources, namely the "Ellen Macarthur Foundation", "McKinsey & Company" and also the European Union, and

aimed to identify the overall barriers and challenges highlighted in the documents and, whenever possible, ways to overcome them.

The second stage consisted on the analysis of a few selected national plans for the transition to a circular economy for which, similarly to the first stage, the goal was to identify how both water and spatial planning were mentioned and how the barriers and challenges were approached. The knowledge gathered from the first stage was the basis for the formulation of an analysis methodology for the plans. In parallel to the national plans for the transition to a circular economy, the Portuguese "National Plan for the Efficient Use of Water" was also studied to gain direct insight on the state of water and water related measures for Portugal.

The third stage took advantage of all the information gathered from the previous two chapters, more specifically the key actors identified, in order to contact relevant actors in the Portuguese context to get an insight on the barriers and challenges as seen from the eyes of the experts that are actually responsible for the management of water and its infrastructures. The process described is displayed in the flowchart in figure 1.

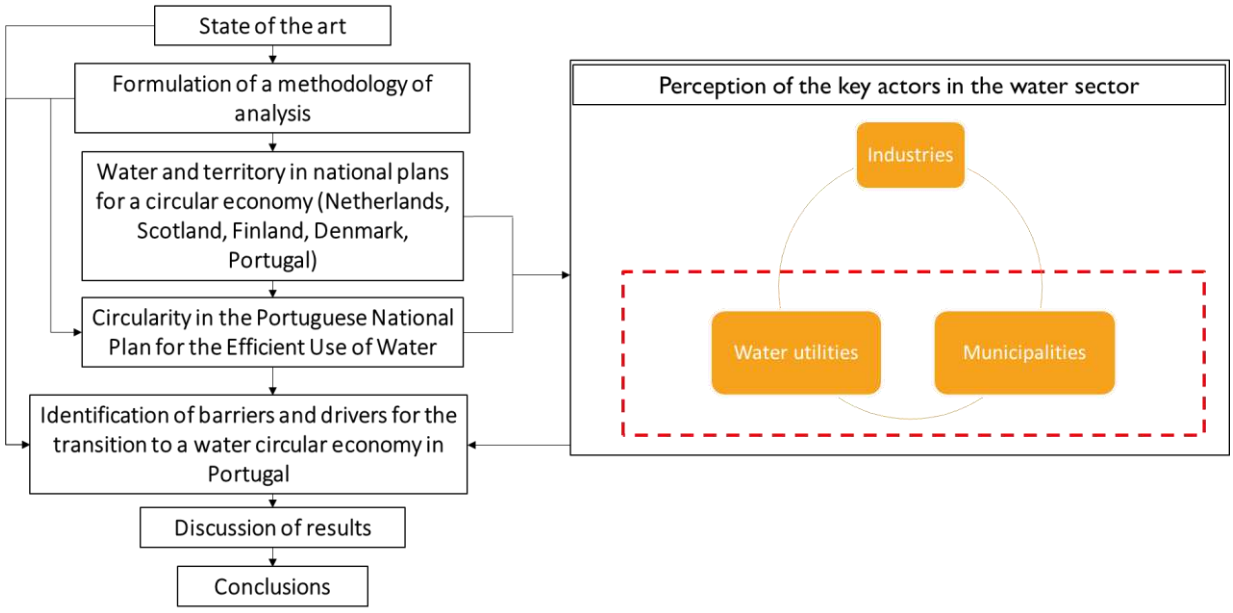

Figure 1 - Flowchart with the methodology applied to the dissertation.

1.3 Structure

The topics to be addressed by this dissertation follow the order depicted below:

1. **Introduction –** This chapter addresses the origins and the pertinence of the subject of circular economy, but also sets the major guidelines of what is expected to be achieved by this dissertation and the processes to reach those goals.

2. **Literature review –** This chapter consists on an analysis of information gathered mostly from scientific articles on circular economy, water circular economy and circular economy and spatial planning.

3. **Methodology –** This chapter consists on an explanation of the processes and methods employed at each chapter to achieve the results present in this dissertation.

4. **Analysis of national documents for the transition to a circular economy –** This chapter focuses on analyzing national documents related to the transition to a circular economy, with the documents being the Portuguese plan for the efficient use of water and the national plans for the transition to a circular economy from five countries, Portugal, Scotland, Netherlands, Denmark and Finland.

5. **Water circular economy in Portugal –** This chapter addresses the matter of circular economy as seen by the experts directly or indirectly related to the subject. In order to get insight from the selected experts a set of questions was established which address the matter at study in the most comprehensive way possible.

6. **Discussion of results –** This chapter consists on a discussion of the results obtained in all the previous chapters.

7. **Conclusions and recommendations –** This chapter consists on some final remarks on the obtained results, providing also some recommendations for future studies on the subject and addressing some limitations found.

2 Literature Review

This literature review consists on an analysis of scientific articles, from online databases, namely *Scopus* and *Web of Science,* with a relevance to the subject being studied. To reach the desired outcome several criteria was defined that allowed to refine the results and highlight the more important articles. Starting with the research the words used were "Circular Economy", "Circular Economy" AND water, "Circular Economy" AND "land* use*" OR "spatial* plan*". For circular economy alone the results were vast, while for circular economy and water they were considerably lower, and even more for circular economy and spatial planning as observed in figure 2.

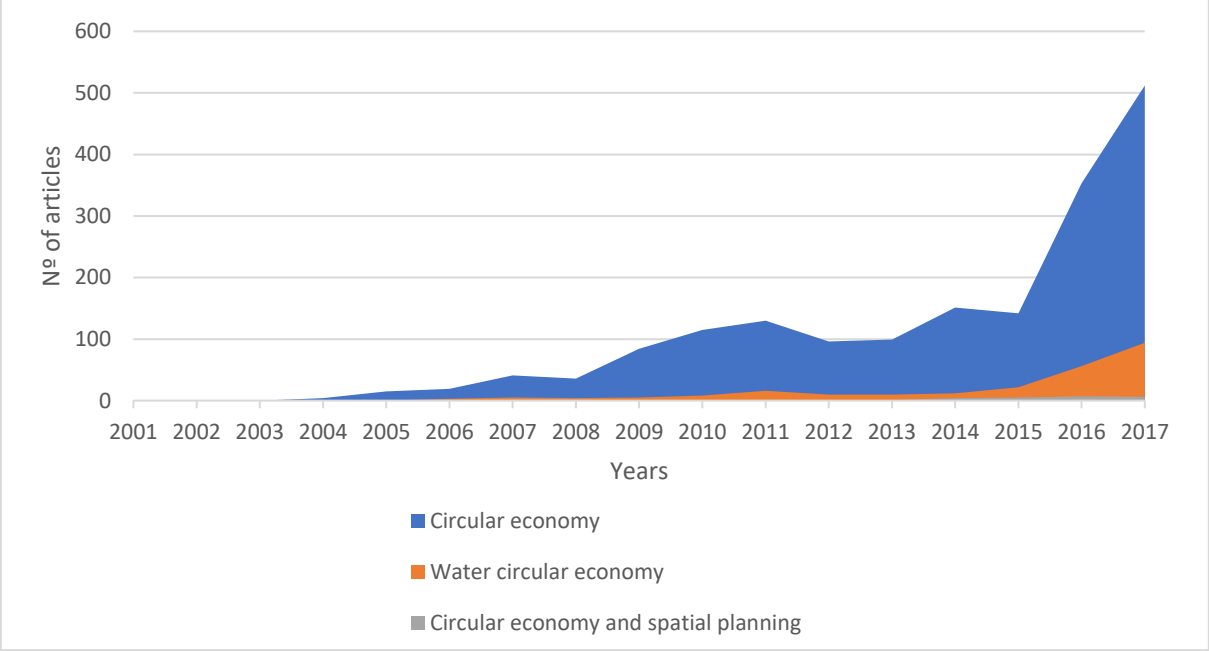

Figure 2 - Articles on circular economy from Scopus.

In order to do a small evaluation on the state of the art on the subject of circular economy, a quick search for scientific articles was made on an online database (*Scopus – 16/10/2017*) by looking for the broader topic, circular economy itself. To withdraw relevant information from this large number of articles a refinement method was needed and the chosen one was the number of citations, followed by the reading of the articles potentially relevant, and a consequent selection of papers. From the five

most quoted articles, four are related to China's activities associated to circular economy (Huang, Guo, and Xu 2009; Peters et al. 2007; Shi, Chertow, and Song 2010; Yuan, Bi, and Moriguichi 2006) and only one article approaches the subject under a more comprehensive view of the concept (Tukker, 2015). China has shown an accelerated social and technological development experienced by the country, with consequent impacts on both the environment and the economy, which helps to explain the investment on the research helping to drive this development towards a sustainable path.

There are two main conclusions that come out of this small analysis, with the first being the fact that China is investing on the transition to a circular economy, evidenced by the amount of studies done on the matter, and the second is the fact that these studies are quite relevant for the scientific community in general, considering that out of the thousands of existing documents focusing on circular economy, the ones more frequently used by other investigators are Chinese studies.

2.1 Introduction

According to the IWA, (2016) (International Water Association) (which, in turn, cited *Growth Within: A circular economy vision for a competitive Europe, 2015 (The Ellen MacArthur Foundation)*), with a transition to a circular economy, by 2030 Europe should see a doubling of economic benefits, 11% growth in average disposable incomes and the decrease by half of the CO2 emissions. And a more specific example from (Ellen MacArthur Foundation 2015), a circular economy implementation could lead, in Denmark, to 0.8–1.4% additional GDP growth, the creation of 7,000–13,000 job equivalents, 3–7% reduction in carbon footprint, and 5–50% reduction in virgin resource consumption for selected materials. This literature review focuses on the analysis of the published papers to date in an attempt to find the links between circular economy, water and spatial planning, while at the same time identifying the reasons why circular economy is expected to improve our society.

2.2 Circular Economy

There are many ways to define circular economy with all of them being true. Quoting Stahel, (2016), "*a circular economy would turn goods that are at the end of their service life into resources for others, closing loops in industrial ecosystems and minimizing waste. It would change economic logic because it replaces production with sufficiency: reuse what you can, recycle what cannot be reused, repair what is broken, remanufacture what cannot be repaired.*" Or as stated by McKinsey, (2014), instead of the current linear process, circular economy intends to use and reuse natural capital to its absolute

potential, finding value through the life cycles of finished products and being, as such, restorative by design. Whatever the definition given to circular economy, its objective is to replace the current linear model that has been present in society for several decades, being at this point an intrinsic value of it and demanding a considerable effort to be altered. And there really is a dire need for change given that this model originates serious environmental consequences due to the fact that the products consumed have a limited lifespan, requiring a constant exploration of the environment searching for raw materials, leaving behind a trail of both physical and chemical pollution, while at the same time depleting the stocks of resources, most of them nonrenewable.

Circular economy steps forward as a concept that promotes the closure of the loop (going, this way, from a linear to a circular economy). As a way to achieve its goals, the concept emphasizes the life cycle extension of the products and the materials that constitute them through repairs, reutilization, improvement and innovation, mixing old products with new technologies, and lastly, when all other options have been discarded, recycling. On top of all the environmental benefits arising from the reduction of material extraction and the lesser amount of products sent for deposition, it also has numerous economic advantages that arise from the need to valorize the products through each step of its life cycle, creating new job opportunities, requiring specialized labor, fomenting innovation and exploration of new technologies, and also requiring the cooperation between several entities (Ellen MacArthur Foundation 2015).

From this need of cooperation several concepts surface, like for example the “Green Virtual Enterprise Breeding Environment (GVBE)”, which’s goal is to promote strategic connections between companies and the institutions that support them in a way to promote the sharing of resources, like information, materials, water, energy and infrastructures, trying to achieve a sustainable development in a collaborative way. One of the main goals Is the “zero waste”, following the principles of circular economy, and to achieve that goal the industrial symbiosis process promoted has a huge contribution, trying to make one industry’s wastes into another’s raw materials, like exemplified in figure 3 (Romero and Molina 2012).

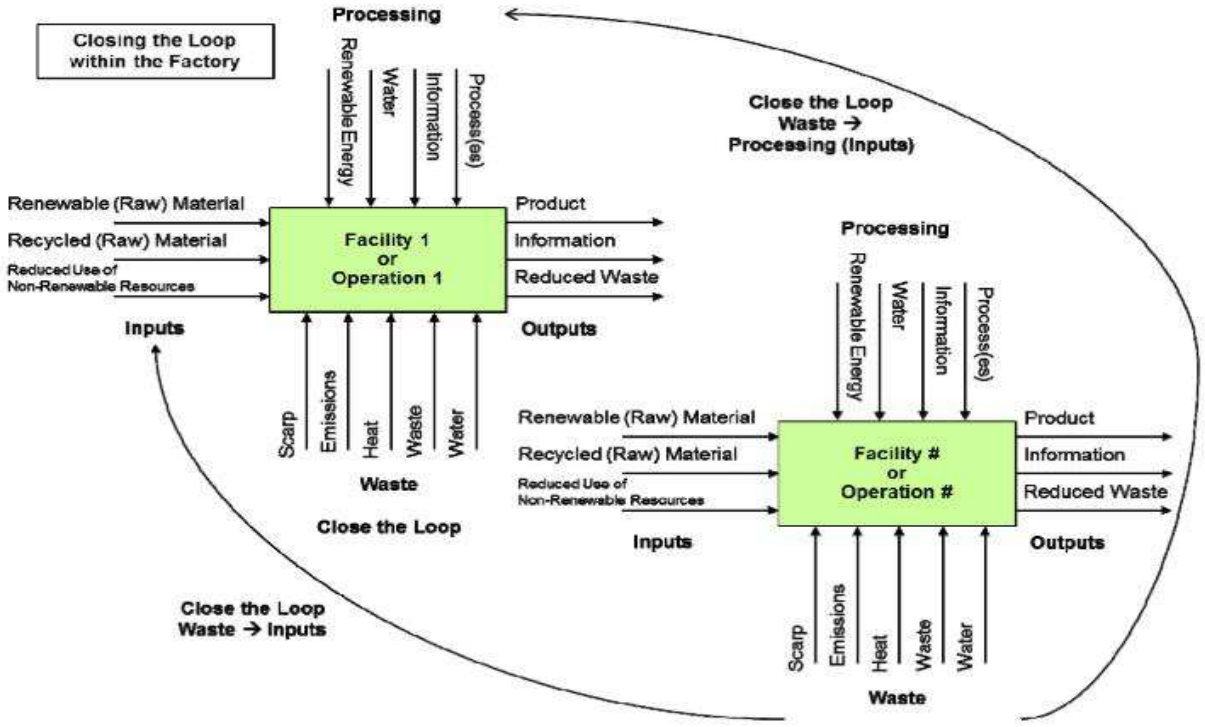

Figure 3 - Schematic example of an industrial symbiosis.

Source: Romero & Molina, (2012)

This concept is just one example among many that have appeared with the objective of promoting a sustainable economy, capable of integrating the needs of the population with the environmental needs, basing itself in the circular economy concept. These new ideas translate themselves into a "greener", more competitive economy, benefiting both industry and citizens, and diminishing the consumption of resources and the production of waste.

It's also relevant to mention another aspect regarding the implementation of a circular economy model, concerning the economy growth. According to Ghisellini, Cialani, & Ulgiati, (2016), circular economy is not an appropriate tool for growth-oriented economic systems, for which efficiency is not a synonym of success, and the rebound effect and market competition can diminish the potential benefits of better efficiency. On the other hand, for a steady-state oriented economic system as well as in possible future descent stage of some economies, circular economy policies and chains of action would become extremely relevant factors, orienting the measures for the transition to new production

and consumption patterns, while delaying (if necessary) the descent and allowing a smoother transition to new “greener” lifestyles and socio-economic dynamics.

2.3 Water Circular Economy

The current model of water use follows the same linearity logic applied to the materials, starting with the extraction, then the utilization, ending with the discard, as of a residue. This process makes water successively more polluted as it progresses through the system, reaching an eventual state of degradation where future utilizations become either impossible or with extremely elevated costs, at least according to current technology. This aspect is even more relevant when the importance of water as an essential asset to every living being and the human society is brought into the question, and that due to a negligent use over the course of several decades has become more and more scarce (Martin Stuchtey 2015). The evident need for changes converges with the circular economy concept, for which the focus would be the prevention of water contamination when possible, and in the cases that it isn’t, use it on a closed loop, maximizing its life cycle. However, according to Abu-Ghunmi, Abu-Ghunmi, Kayal & Bino, (2016) the studies that apply the circular economy concept to the water resources management has received considerable less attention than those that focus on the material flow, even though they both share the same principles.

On another subject, Puyol et al., (2016) reveals that between 50 and 100% of lost waste resources are contained in wastewater, giving further strength to the claims for an improved wastewater management and treatment. More so, the authors also state that around 20% of the manufactured nitrogen and phosphorous is contained in domestic wastewater, with most of it being potentially recoverable due to urban concentration. They also mention that wastewater contains 1,3 MJ/person/day of chemical energy, which represents 1% of the current world total energy consumption, or 4% of the world total electricity. For all those reasons, economists, environmentalists and industrials are pushing to recover all those substances, making it an important economic opportunity while also preventing environmental consequences. As a way to recover some of the constituents present in wastewater, the article also mentions a concept, of its name “Partition-Release-Recover”, which uses biological agents to selectively remove nutrients and carbon from the liquid phase. This process can effectively treat wastewater with basically no energy consumption, while

recovering nitrogen, phosphorous, and potentially, value-added organics or microbial products from the effluent, as represented in figure 4.

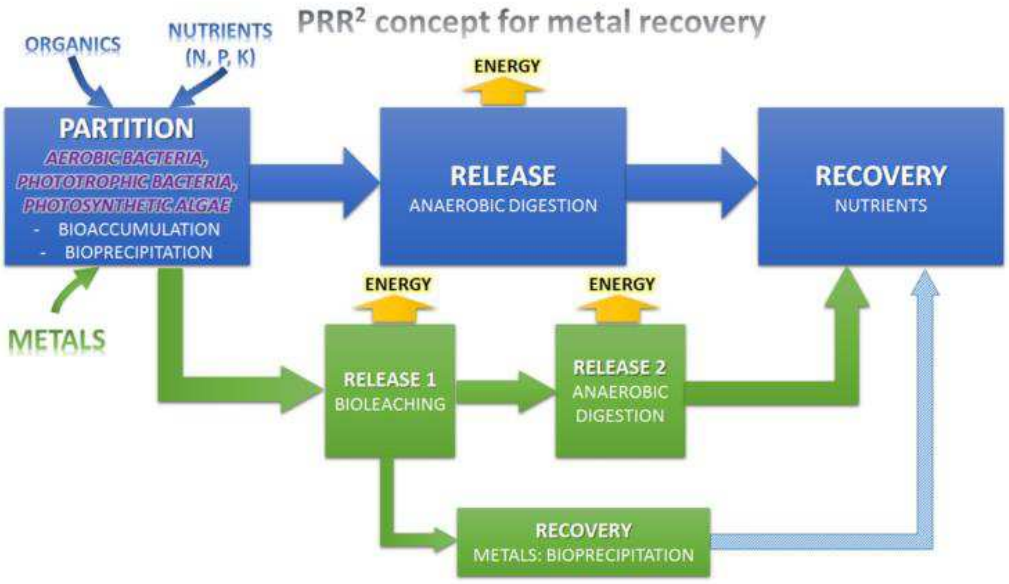

Figure 4 - Overall scheme of the Partition-Release-Recover concept.

Source: Puyol et al., (2016).

In a way to promote changes to the current waste-water system, a study undertaken by Schramm, Kerber, Trapp, Zimmermann, & Winker, (2017), Identifies the main barriers to this field as:

- Legal restrictions and uncertainties;
- Financial and economic uncertainties;
- Uncertainties regarding the ideal design.

One of the legal uncertainties is linked to the supply of both drinking and service water[1]. This division would imply a need for additional water-supplying connections or changes to the regulations, demanding dishwashers and washing machines to be connected to a separate water system.

The same study highlights the blackwater collection system from the water company *Hamburg Wasser*, in Hamburg, as one of the most innovator systems implemented. The system, applied to 800 houses,

[1] Water that does not meet drinking-quality standards.

collects blackwaters through vacuum, using only a small fraction of the water used by other conventional toilets. That water is then used to produce biogas for heating and electricity in another facility, taking the most out of the available resources. According to the investigators, for the system to operate efficiently the transfer point of water from the private domain to the domain of public infrastructure may have to shift from the boundaries of private property to the pipes and toilet inside a home. This technology also allows to evidence the fact that for the water companies to be able to innovate, it's necessary a political backing able to answer the needs of the companies, while assuring the compliance of the system with the even the most demanding European laws. To achieve that, it's necessary a strong cooperation between all the entities, from public services, to investors, civil construction, among many others. The authors also mention that the waste-water management in Germany is based on a uniform, centralized approach, with the responsibility of its supervision being relayed to the municipalities. However, new technologies like this vacuum system, require decentralized systems, with technologies applied to the house, block or local-area. As these infrastructures could be owned or operated by private companies instead of the water utility companies, this could represent new business opportunities. On top of that, supplying service water from grey-water and rain water, or collecting and treating black-water separately, can represent another business opportunity, producing biogas from black-water and recovering heat from sewers.

Taking now the analysis to a more economical-focused point of view, a study from Abu-Ghunmi et al., (2016) analyzed the data from 27 waste-water treatment plants in Jordan for 2012, although due to some data not being available and in a way to homogenize the study by effluent type and volumes of waste-water, only 14 stations were considered. All the selected stations have three types of treatment: primary, based on physical operations; secondary, based on bio-mechanical aerobic processes; and a third process in which the effluent is disinfected with chlorine. The economic parameters for each station include the capital costs, the annual operation costs, which include money spent with energy, staff, reagents, among others, and the selling price of treated waste-water for irrigation purposes. Using the selling price of treated waste-water for irrigation of the year the study was conducted, the obtained results indicate that the costs outweigh the benefits, both environmental and financially, of going circular. However, raising the price from 0,023 to 0,075 JOD/m^3 (still far below the average price of drinking water), the net product value (NPV) reaches around 68,9 million JOD, even after adjusting for inflation. This study concludes that, in Jordan's case, the adoption of a circular economy model for

the water sector is justified on economic grounds and is, therefore, a need for the country as a way to improve its water efficiency and preservation, being it a scarce resource in the region.

Other authors, namely Koop and van Leeuwen (2017) approach the matter of water circular economy in the context of smart cities (exemplified in figure 5), describing them as:

- Cities with a coherent long-term social, economic and ecological agenda;
- Water-wise cities that integrate their sectoral agendas on water, wastewater, energy, solid waste, transport, ICT (information and communications technology), climate adaptation and nature into a forward-looking, coherent urban agenda to maximize co-benefits and to minimize the cost;
- Cities that implement a circular economy, focus on social innovation and greatly improve on governance.

They also approach the opportunities for the water sector, focusing on the drinking water sector and the conditions, summarized as the three Rs: “Reframe, Refocus, Radically”. Reframing because water challenges require a broader framing, as water is much more than just drinking water; Refocus because the success of a better water efficiency come mostly by focusing on governance, not expecting technology to solve all the problems; Radically because of the speed at which the world is changing, with urbanization at a rate of 190 000 people per day, the shift in the labor market (e.g. the exodus of business and employment form Europe) and the safety of cities concerning climate change and water security.

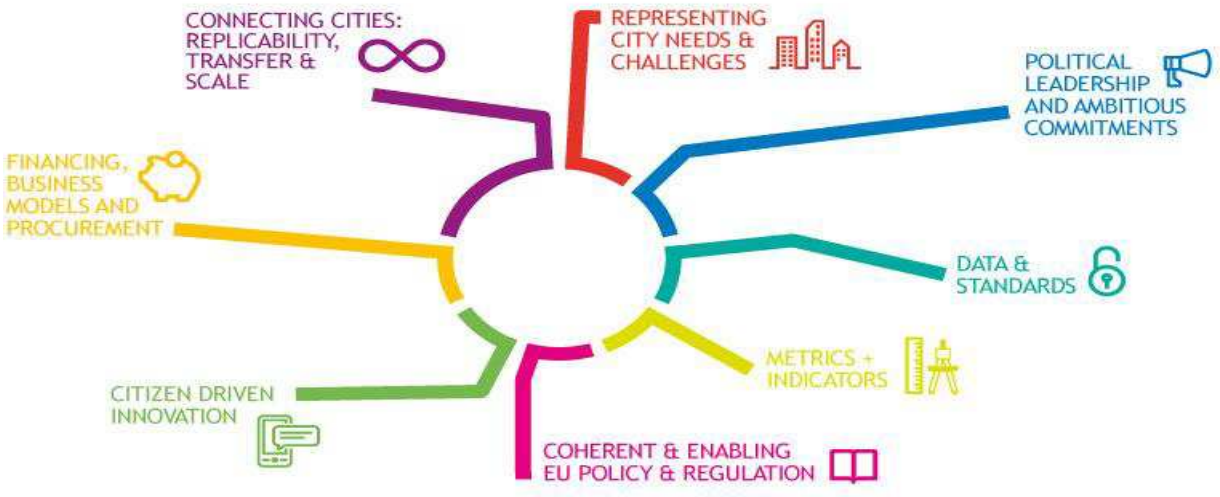

Figure 5 - Example of smart city configuration.

Source: www.eurocities.eu/eurocities/issues/smart-cities-issue#

As seen in figure 5, a smart city is a concept that focuses on the connection of all sectors, promoting the integration and participation of all stakeholders in the improvement and development of a city.

2.4 Circular Economy and Spatial Planning

Land use plays an important role as an enabler and promoter for circular economy, in the way that it can facilitate the actions of all the stakeholders by providing the necessary conditions for a successful flow exchange.

According to Mattila, (2016), the regions and municipalities can create possibilities and support conditions for an industrial symbiosis and circular economy overall. The author exemplifies with the case of Forssa, in Finland, as a successful case, where in the 90s the municipality reserved a large area surrounding the existing landfill for future development needs. After the development of the region, it can be found in the area around 20 types of different companies with high synergy among one another, exchanging resources between them, in a similar way to what has been shown in figure 3, but on a much larger scale. As evidenced by this case, land use management allows for a better organization of both needs and productions of each company, planning ahead of time which type of industry would synergize well with one another in a way to create a network of companies with possibility of interactions among themselves, diminishing transport distances and, consequently, both the associated costs and environmental impacts.

Other authors, namely Frank & Marsden, (2016), approach the matter of scale, and which would be the most appropriated for land use planning. According to them, a national scale tends to be too generalist to be able to fully take advantage of the specific conditions of some locations, while a local or regional scale is too narrow and makes it harder to coordinate aspects that would benefit from a more expansive approach, as is the case of transportations management. The authors also state that a regional scale allows to foment a sustainable development, facilitating the monitoring and management of resource flows and externalities, taking into account the affinities between cities, urban and rural areas. On top of that, it allows to overcome political divergences and difficulties that may arise from political decisions with more ease.

On another hand, Fernández, (2007) approaches the subject of emerging cities, particularly in China given its fast socio-economic expansion, and how it should be planned and managed the construction

of new urban areas, in a way to obtain fast results, but in a sustainable manner. According to the author, the first step should be the improvement of both the quality and sophistication of materials, technologies and design. On top of that, improvements on the energetic efficiency of the buildings would contribute, in a large scale, to the reduction of their operational costs, both environmentally and economically. This aspect arises naturally from better construction practices and appropriate and reasonable legislations, and their execution and monitoring. The author also reveals the individual directives he considers as promoters of a circular economy in the building sector, while at the same time promoting the development of the sector, as being:

- The design of the products – referring to the improvement of performance from buildings' systems, namely the exterior part and the refrigeration systems, on top of a bigger focus on domestic industries that produce high quality products;
- The industrial design – the industries and the government should focus on matter and energy exchanges in the sector, in an attempt to develop partnerships between industries and thus developing industrial symbiosis;
- Cities design – it should be made an analysis to cities metabolism in an attempt to characterize resources consumption and identify opportunities of improvement on design, planning and city operation.

2.5 Water Circular Economy and Spatial Planning

The reviewed literature shows a severe lack of studies concerning the connection between spatial planning and circular economy, and even more when specified on water circular economy and spatial planning, an aspect somewhat expected due to the just recent attention the subject has been receiving. That being said, by analyzing the literature on each of these topics separately, there are a few main conclusions that have been drawn.

First, the main actors concerning the water circular economy and spatial planning are those that directly or indirectly influence the management of large volumes of water and its transportation, namely:

- Waste-water treatment plants and public water suppliers (water utilities) – these are the ones responsible for handling most of the water used by both public and private parties, and any change

to the current system would directly influence them, as such they are unavoidable entities when trying to make any change to the current system;

- The governments – as evidenced by the Forssa case, an ahead of time planning of industrial areas can greatly contribute to synergies between companies, saving time and resources. On top of that, specific legislation can facilitate the implementation of circular economy models. Municipalities play a larger role than national-level government, but the latter is the main responsible for legislative changes which can be "game-changers";
- The industries – somewhat connected to the previous point, partnerships between industries could create cases of industrial symbiosis with great profit for the companies and the environment. Although the municipalities play an important role on this matter, ultimately, for private companies the decision would still be theirs to make.
- The general population - although it doesn't influence the management of water directly, it has a relevant role as consumers, and the pressure applied in some situations can greatly affect the outcome of some measures.

After identifying the main actors, it becomes necessary to identify the key aspects that can influence the transition and implementation of a water circular economy. These aspects can be related to any of the actors and are, overall, inevitable to a fully functional circular economy. The most relevant are:

- Legislation and regulation – these can originate from a broader entity (European legislation, for example) or be specific for a country or region. It's one of the main features that can either facilitate or completely undermine a transition to a water circular economy;
- Economic factors – a transition to a water circular economy usually requires an investment on new infrastructures or improvement of the ones already in use, new business deals (and possible the termination of others already in existence), the creation of new, qualified job opportunities, etc;
- Innovation – this aspect is somewhat volatile as it can hardly be forced, but a focus on innovation could lead to new techniques and technologies that make the whole system cheaper, more effective, and allowing for new possibilities previously considered impossible;
- Cooperation – the cooperation between companies that share material flows and knowledge among themselves is a big booster of the overall development of the concept, making it easier for new ideas and technologies to arise;

- Behavioral tendencies – some built-in ideas people have can influence the measures adopted by industries so they can fit the market ideals. For example, the use of nutrients from waste-water as fertilizers in agriculture can be a considered a negative aspect for many people who are not fully aware of the subject.

Overall, the general idea is that a water circular economy cannot be achieved without a strong cooperation between public entities, industries and all the stakeholders. And if by one hand the government has a massive role to play, it also needs to exist a commitment from the industries to achieve a balance between the economic and environmental aspects.

2.6 Conclusion

Circular economy presents itself as a restorative and regenerative model by default, aiming to maintain products, resources and materials at their highest possible value, for the longest period of time. This new model is not completely incompatible with the current linear model (on a macro scale), in the sense that the transition can't be made instantly, so at any given point in the short-term future both linear and circular economy will coexist, with the previous one being gradually replaced, until, in a long-term future, only circular economy will remain (ideally).

As a recent concept, circular economy still faces many challenges, either financial, technological, legislative or others, but the potential for improvement is vast and trough innovation and cooperation the goals for a sustainable development are far from remote. And water, being a key figure in the circular economy for its importance as a scarce but incredibly valuable resource, has a major role to play and the entities that regulate its consumption are essential for a successful circular economy implementation. In turn, spatial planning has also a major role as a facilitator for all areas of circularity, and industries and governments, as the main responsible for its management, are the ones that can either make the wheel spin or break it.

3 Methodology

For the elaboration of this dissertation a qualitative approach was used, with data being collected primarily from scientific articles, which constituted the literature review, followed by the analysis of relevant documents for the transition to a circular economy, and lastly a direct contact with experts from relevant areas for the transition to a water circular economy.

Starting with the following chapter, the fourth, it consists on an analysis of national documents with relevance regarding the transition to a circular economy. These documents include five national plans for the transition to a circular economy from five countries: Scotland, Denmark, Netherlands, Finland and Portugal, and a document addressing the efficient use of water for Portugal. There was no particular reason for the choice of the countries as there was no way of knowing which ones would contain the most (relevant) information. The first step of the analysis of the national plans for circular economy was a simple word frequency count, resorting to the program *WebQDA*, with the top ten words with more than four letters being registered for each plan. However, since the goal of this study is to see how water and spatial planning are mentioned in the plans, and since none of them were mentioned frequently enough to be present in the top ten words, a separate analysis, again resorting to *WebQDA*, was undertaken, this time looking for specific words, more precisely “water” and “spatial”, to get a general idea on how much were the topics addressed in the documents. A larger number of specific words was included but as the results were not showing as they were supposed to (maybe due to some lack of experience at handling the program) and since the same results but with a larger detail would be presented immediately after, those two words were accepted as the only screening references. After this first analysis and to properly compare the documents, a generalized system was needed that would allow to split all the information of each document, using the same criteria. With that in mind, and following guidelines from (M. Howlett 2015; Michael Howlett 2017) a set of five generic topics was defined, each of them corresponding to a typical chapter content, thus allowing to use the same generalized “structure” for all the documents. The next step was the screening for specific content related to both water and spatial planning that were then split between the mentioned topics according to their focus. This step was carried by searching for specific words, namely: “water; hydric*; spatial; land use; plan*; territory; governance”. Once again, the words with “*” had also variants searched, like for example the word “hydric” had also “hydro” looked for. After identifying all the

relevant words, the resulting tables were analyzed. Immediately following this analysis, it was time to address the document related to the efficient use of water for Portugal. The first step was to search for direct references to circular economy, but since none were found, the analysis consisted on a summary of the document, with particular attention to the most relevant topics in some way related to a transition to a circular economy.

The following chapter addresses water circular economy in Portugal as seen by the experts of several fields in some way relevant for the transition to a circular economy. The selection of experts resulted of both brainstorming and recommendations from other experts and the contact was made via e-mail. A set of six questions was prepared based on the information gathered in the previous chapters, but taking into account the different areas of expertise of the experts, the questions were elaborated as comprehensively as possible. Then, depending on the availability of the chosen experts, the contact was made either via skype, cellphone or in person, when possible, and via a word document when the availability was limited.

4 Analysis of Documents for the Transition to a Circular Economy

4.1 Introduction

In an attempt to better understand the focus and objectives of each country's circular economy plans, especially regarding the water and its relationship with spatial planning, five national documents from five countries were selected and analyzed: Portugal (Grupo Interministerial Economia Circular 2017), Netherlands (Dutch Ministry of Infrastructure and the Environment & Ministry of Economic Affairs 2016), Scotland (Scottish Government 2016), Denmark (State of Green 2016) and Finland (Sitra 2016). These documents set the guidelines and the pace for the implementation of a circular economy at a national level and, as such, contain extremely relevant information regarding the approach taken by each of them.

The analysis of these documents consisted, on a first stage, on comparing their structure as given by the index to get an early impression of how each country is approaching the circular economy matter, while also trying to identify right from the start water and spatial planning references, and also a word frequency analysis. After this step was the logical reading of the documents, in which the focus was to identify specific content related to the topics of interest. This step gives an extensive idea of the general focus of each country, while also allowing to check how spatial planning and water are approached when linked to the several sectors of circularity. The third stage consisted on a screening for specific content related to both water and spatial planning (not necessarily both simultaneously since, just like in literature review, the connection between them is hardly explored). This step was carried by searching for specific words, namely: "water; hydric*; spatial; land use; plan*; territory; governance". The words with "*" had also variants searched, like for example the word "hydric" had also "hydro" looked for. This allowed to isolate the topics where water and spatial planning were mentioned, enabling an analysis on the context and the approach for each situation, while also safeguarding any missed reference during stage two.

4.2 National Plans for the Transition to a Circular Economy

As a first approach to the analysis of the national plans for the transition to a circular economy a simple word frequency study was performed to the documents of five countries, more specifically Portugal, with the document ”Leading the transition – action plan for the circular economy in Portugal: 2017-2020)”; Scotland, with the document “Making Things Last: A Circular Economy Strategy for Scotland”; Netherlands, with the document “A Circular Economy in the Netherlands by 2050”; Denmark, with the document “Circular economy – Denmark as a circular economy solution hub” and Finland, with the document “Leading the cycle : Finnish road map to a circular economy 2016-2025” (Dutch Ministry of Infrastructure and the Environment & Ministry of Economic Affairs 2016; Grupo Interministerial Economia Circular 2017; Scottish Government 2016; Sitra 2016; State of Green 2016).

This sort of pre-analysis resorted to an online program *WebQDA*, a software used as a support for the analysis of qualitative data that allows the intersection and organization of non-numerical and non-structured data, create interpretative or descriptive dimensions, and also possesses a questioning system that permits to question the data being studied. For this analysis specifically, the last ability was also the most relevant, as it was used to take a first glimpse on how each country is addressing the circular economy subject by studying the word frequency for each document, thus providing information on a few topics considered to be as relevant by the sheer number of times they are quoted. The results obtained are displayed in figure 6. Important note, all the documents were directly uploaded into the program, however, since the Portuguese document file was bigger than what the program could process it had to undertake a step in which it was compressed prior to its introduction in the *WebQDA* program.

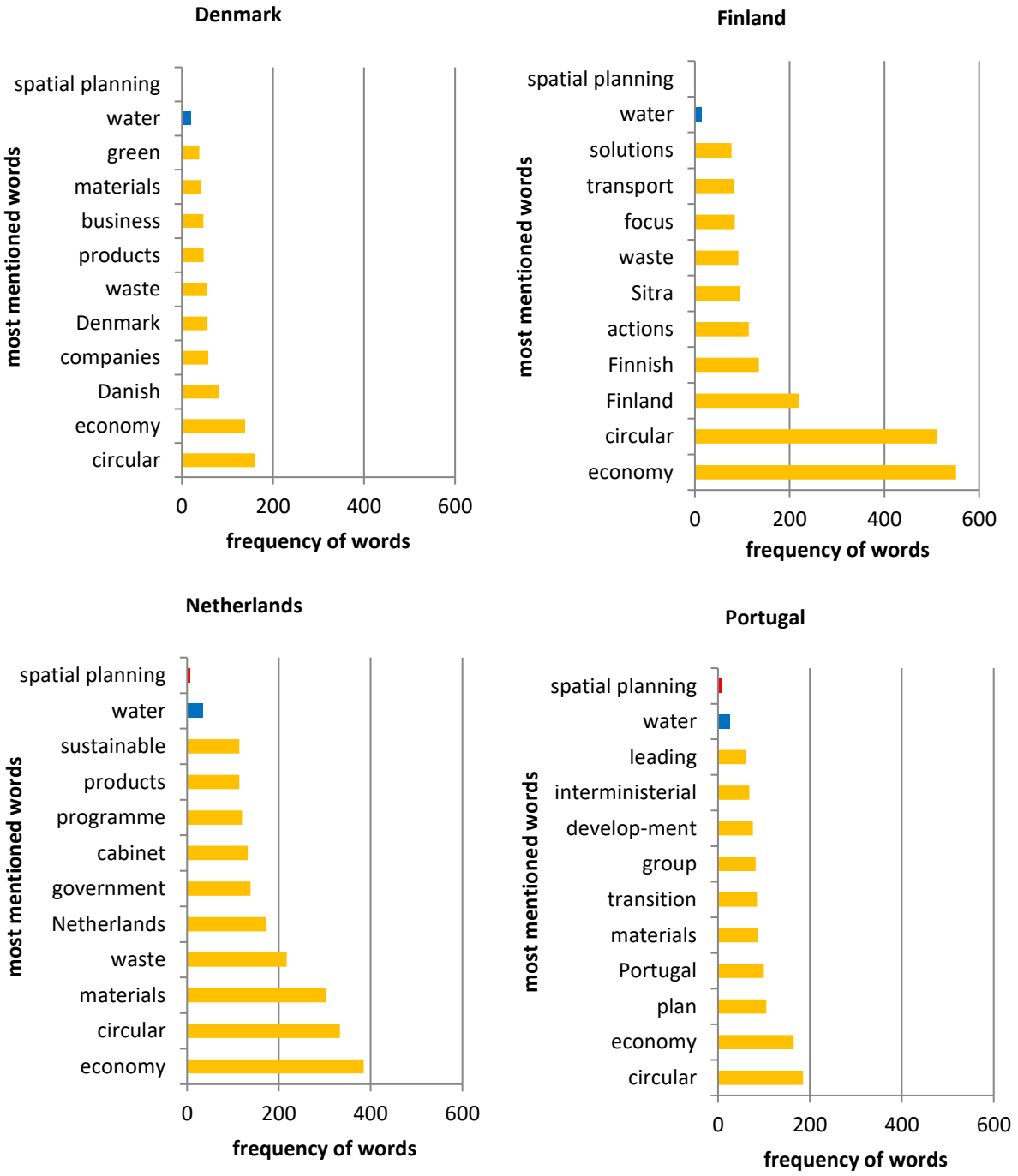

Figure 6 - Word frequency analysis for the selected national plans.

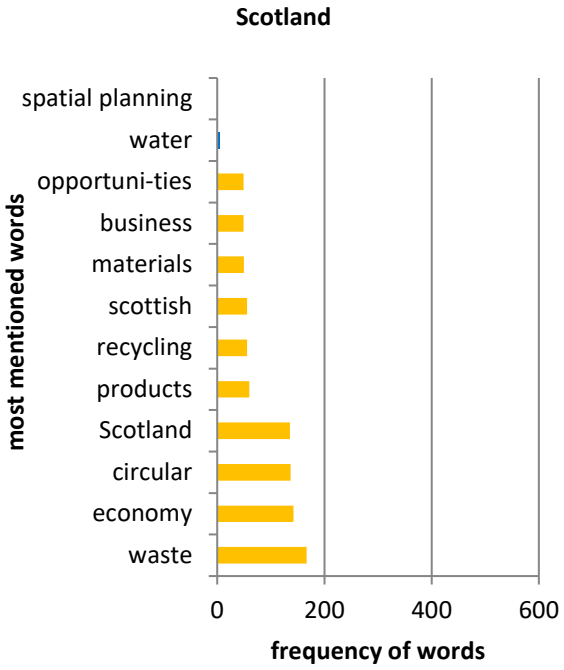

Figure 6 – Continuation.

Through the analysis of the figures it is possible to verify that the words “circular” and “economy” are the most frequently mentioned for every country (with the exception of Scotland which has waste as the most mentioned), something perfectly logical considering that the whole focus of the documents is to address the transition to a circular economy. Then comes waste and materials, each present in the top ten in four of the five documents. The first evidences the relevance that residual products have for a circular economy, were it not this one of the focus of the concept, the reutilization or recycling of materials, while the second addresses the materials themselves, which as evidenced by the literature review are still the major focus for the circular economy. After these words the most frequently repeated terms for each country varies accordingly to the priorities each has given for the transition to a circular economy.

However, one of the most relevant aspects of this study is related not to the most mentioned words, but to the absence of some words from the list, specifically water and spatial planning. As mentioned previously in the literature review, the relevance of these two topics is quite significant and the seeming lack of consideration for them from government documents reveals some shortcomings that could

hinder, at least partially, the transition to a circular economy. As a small reference an individual analysis was undertaken to look specifically for both water and spatial planning for each document, again resorting to *WebQDA*, with the results being displayed at the top of each graphic, spatial planning in red and water in blue.

4.3 Structure analysis

The structure of the documents allows to take a first glance at how the governments are approaching the circular economy matter in general while also enabling to check for references to water and spatial planning right from the chapters and subchapters. On top of that, the order in which the topics are mentioned and even topics that aren't mentioned can represent valuable information regarding the overall content of the documents.

The structures (chapters only) were placed side by side, as shown in table 1, but the notorious difference in information displayed made it complicated to properly extract data and even more to compare it between the documents at hands, making this first analysis quite superficial, as expected.

The first noticeable aspect, regarding these structures only, is the fact that while Portugal, Netherlands and Finland kept their chapters broad, specifying the information in the subchapters (or sub-subchapters for Finland), Scotland and Denmark set more specific chapters, revealing right from the beginning all the contents of the document. This has obviously no consequence other than making the structure comparison trickier, since there is not much to be analyzed. Still, looking at these chapters there are a few evident aspects regarding the approach to the circular economy matter, for instance, Denmark, Netherlands and Scotland include a chapter where the need for change, for a transition, from the linear to the circular model is highlighted, emphasizing the idea that the current economic model is no longer valid and it needs to be replaced by a more sustainable and effective model. Another visible feature is the focus on the material aspects of the circular economy, with the words like products, waste and materials appearing frequently as chapter worthy headlines, while water and spatial planning aren't directly mentioned in any of the major topics titles.

Table 1 - Chapter distribution for the five national plans selected.

Portugal	Netherlands	Scotland	Denmark	Finland
Prefácio (foreword)	A circular economy in the Netherlands by 2050	Executive summary	From a linear to a circular economy	Foreword
Sumário executivo (executive summary)	Promising prospects	Introduction	Designing products for the circular economy	Road map
Introdução (introduction)	Raw material use: the great challenge of the 21st century	Making the transition	Circular consumption through innovative business models	Background report
Planear (plan)	Changing course	Waste prevention	Looping resources	Appendix: working group
Agir (act)	Interventions	Design	Resource-efficient production	
Referências (references)	Priorities	Reuse	Turning biological side streams into value	
Equipa (team)		Repair	Building circular	
Agradecimentos (thanks)		Remanufacture	Unleashing the potential of circular economy	
		Recycling		
		Producer responsibility for reuse and recycling		
		Recovering value from biological resources		
		Energy recovery		
		Landfill		
		Communications and engagement		
		Skills for a circular economy		
		Measuring progress		

After this first analysis and to properly compare the documents, a generalized system was needed that would allow to split all the information of each document, using the same criteria. With that in mind, and following guidelines from M. Howlett (2015); Michael Howlett (2017) a set of generic topics was defined, each of them corresponding to a typical chapter content, thus allowing to use the same generalized "structure" for all the documents. The topics are "Problem showcase"; "Objectives"; "Measures and strategies"; "Stakeholder analysis" and "Performance indicators".

4.4 In depth analysis

The following analysis started by assigning each reference to water and spatial planning to one of the aforementioned topics for each document, that were then compared depending on the number of references and also their focus. There are, however, a few points that should be mentioned. First, not

all the references are relevant, whether in the context of circular economy or because another similar reference as already been mentioned. Therefore, and in order to keep the analysis as relevant as possible, some of the references are counted but have no quote and no description (it is still possible to see all the references in the appendixes).

Second, one reference does not necessarily mean one time a word related to water or spatial planning has showed up, but a context where it was addressed. For example, in table 2, the first quote from the measures and strategies topic contains six times the word water, and one time the word hydric, but is only counted as one reference. This means that the word frequency analysis from *WebQDA* won't, in most cases, match with the number of references in the following tables.

4.4.1 Leading the transition – action plan for the circular economy in Portugal[2]

Portugal has an "overly simplified" chapter section, consisting essentially of 3 topics: Introduction; Plan; Act. Just by reading these main topics there isn't much information that can be drawn, however there is a clear message being displayed, the need for a plan to smooth the transition and the need for action to actually change things. These two aspects together make up for the basis of any project and the shift towards a circular economy is no different. That being said, lets focus on the matter at study, how is Portugal seeing the water and the spatial planning for circular economy? Starting with water, with the information displayed in table 2 (total references in appendix 1), there are a total of nine references to it with most of them being either a sort of introduction to the problem or a set of measures and strategies to move towards a circular economy.

In the "Problem showcase" the references help to evidence the fact that while Portugal is still behind other countries concerning circular economy and regarding the role of water in the circular economy, it is perfectly aware of that and inclusively looks up for other countries examples in order to improve. In the "Measures and strategies", the focus is essentially about innovation, and the role it can fulfill as a booster for the transition to a circular economy, whether linked to legislation or a direct improvement of existing assets. The "Objectives" and "Stakeholders analysis" have one reference each, and mention an action that has the goal to improve water use efficiency the first, and another example of successful cases from other countries the latter.

[2] All the translations for the Portuguese document are non-official and of my own making and may, therefore, diverge from other translations for the same document.

Table 2 - Water references in the Portuguese document.

Topics	Number of references	Quotes and pages	Description
Problem showcase	4	"Paradigmatic case is the water efficiency in which only 65% of the captured water is effectively used, and where reutilization is, still, residual compared to other member states." (Page 13)	Water efficiency is low and reutilization far below other member states.
		"Green deals - (energy, mobility, climate, biodiversity, bio economy, resources, water, construction, agri-food); (page 20)	Reference to national plans from other countries that directly mention water as a focus.
Objectives	1	Action - "Built environment: more efficiency and material productivity" "Objectives: … Reduce water consumption" (Page 48)	Water consumption reduction mentioned as one of the objectives of a strategy.
Measures and strategies	3	"The first innovation deal approved, in the water sector, supports circular economy. We want the European legislation is easier to implement and use. The innovation Deal helps us in that regard" "Sustainable use of waste water treatment using the technology of anaerobic membranes bio-reactors: This innovation deal approaches legislative barriers to the use of waste waters. This technology eases the extraction of energy and nutrients and accelerates the reutilization of treated water for irrigation, contributing to overcome the challenges of water scarcity. The deal explores the paradigm change: from waste water treatment plant to hydric resources installation." (Page. 30)	Example of measures that allow stakeholders to adapt to regulatory obstacles, enabling an easier transition to a circular economy.
		"Reduces the pressure on soil occupation, avoids the excessive use of water and fertilizers (precision agriculture), reducing energetic intensity (lesser need to refrigerate/transport), allowing industrial symbiosis (e.g. fish production in aquacultures), reducing the need for packages, stimulating production and local consumption… uses 90% less water that the traditional way and doesn't need of pesticides nor herbicides." (Page 41)	Example of an innovative method of agriculture that allows to save water.
Stakeholders analysis	1	"The Valley is the physical location where the ambition to develop the Netherlands into a hotspot in a Circular economy is developed and demonstrated. Materials, water and energy are kept in a continual cycle." (Page 53)	Reference to a project where several companies, an airport and the government cooperate for the transition to a circular economy.
Performance indicators	-	-	-

As for spatial planning the content is displayed in table 3 (total references in appendix 2), and for this document there are four references, with the major focus being related to planned actions for circularity.

Just like the water references, the spatial planning ones are also located, for the major part, in the "Measures and strategies" topic. In both of the quotes selected the main topic approached is the industrial symbiosis and how the regions in which the industries are located can interact with them to facilitate and promote its implementation. Although there is a reference located in the "Stakeholders analysis", it was not considered relevant enough to be mentioned in the quote section.

Table 3 - Spatial planning references in the Portuguese document.

Topics	Number of references	Quotes and pages	Description
Problem showcase	-	-	-
Objectives	-	-	-
Measures and strategies	3	"For the micro level case, the focus are the regions and territories and the strategies of acceleration for a circular economy that better fit the socio-economic profile. Like the sectors case, it's important to establish specific agendas and, currently, some regions already moved on with their own plans, in articulation with Operational Programs of Portugal 2020. Is at this level that the circular economy converges with the valorization of territory, reason why it were selected strategies in which regions are working on (e.g. industrial symbiosis)… " (Page 26)	Reference to strategies and focus in the micro scale of circular approach.
		"The BLC3 wants to accelerate the development of industrial symbiosis between different industries of the region, in which managers interact and share resources to minimize the need for raw-materials and waste production. " (Page 46)	Reference to industrial symbiosis in a region as a method of saving resources.
Stakeholders analysis	1	-	-
Performance indicators	-	-	-

Overall the Portuguese document reveals that is considering both water and spatial planning as somewhat relevant for the transition to a circular economy, as evidenced by the decent amount of references to them. However, the focus for both is a bit narrow, only approaching very specific areas and the lack of connection between the two of them is also noticeable and once again exposes the lack of focus given to the role of spatial planning associated with water circular economy.

4.4.2 Making Things Last - A Circular Economy Strategy for Scotland

The Scottish document reveals a high focus on the material part of the circular economy and its consequent waste production and management through design, reuse, repair, remanufacturing, recycling, among others. Consequently, both water and spatial planning are barely mentioned and through the document there are only five references to water, as shown in table 4 (total references in appendix 3), and three to spatial planning, shown in table 5 (total references in appendix 4).

Table 4 - Water references in the Scottish document.

Topics	Number of references	Quotes and pages	Description
Problem showcase	2	"There are significant environmental benefits to a more circular economy: from reducing greenhouse gas emissions, relieving pressure on water resources, virgin materials and habitats, and limiting pollution of air, soils and watercourses." (Page 7)	Reference to water as one of the resources that would benefit from a circular economy.
Objectives	2	"In 2013 we introduced a target to reduce Scotland's waste by 7% by 2017 from 2011 levels, 15% by 2025. In the same year, we established Resource Efficient Scotland, delivered by Zero Waste Scotland, bringing together expertise and advice on energy, materials and water. This service helps businesses and organisations access support to use resources more efficiently." (Page 11)	Reference to waste reduction goals, with water as a focus (on pair with energy and materials).
		"Linked to the use of fertilizers and growing media, we have committed to supporting the phasing out of peat for horticultural use. Peatlands are important for biodiversity, water quality and reducing carbon emissions – and need to be well managed and protected. The National Peatland Plan sets out Scotland‟s ambitions for protecting, managing and restoring our peatlands." (Page 31)	Water quality protection as a side benefit from protecting peatlands.
Measures and strategies	1	"Reduced requirements for material, water and energy mean remanufactured products can cost less than the equivalent new products, and hence significantly boost productivity, competitiveness and profitability. Remanufacture provides an excellent circular economy business model, especially where products are leased to the customer or have an incentivised return mechanism." (page 22)	Reference to the possibility of reducing product costs by reducing the requirements for water.
Stakeholders analysis	-	-	-
Performance indicators	-	-	-

The document of Scotland does not have a large amount of references to water and the ones it has are somewhat evenly split between the first three topics. The first reference mentioned, in the "Problem showcase" topic, clearly shows that water is one of the resources that would benefit greatly from the

transition to a circular economy and should be therefore considered as a priority. Next is the "Objectives", which focuses water protection, directly through improved efficiency in its use, or indirectly by protecting the peatlands. And the final reference, in the "Measures and strategies" topic, approaches the legislative barriers, namely the minimum requirements for a given resource to be used, which if lowered can dramatically improve the remanufacture efficiency.

Table 5 - Spatial planning references in the Scottish document.

Topics	Number of references	Quotes and pages	Description
Problem showcase	1	-	-
Objectives	1	-	-
Measures and strategies	1	Where thermal treatment plants are required, we wish to see only high quality combined heat and power schemes developed. As with other thermal electricity generation plants these should be located where there is a demand for heat to make the most of our resources, while minimising environmental impacts including meeting Scotland‟s high standards on air quality. This is supported by a regulatory framework through planning, Pollution Prevention and Control regulations on the use of waste heat and by programmes such as district heating support for local authorities. (Page 33)	Spatial planning as a way to prvent environmental impacts.
	-	-	-
Stakeholders analysis	-	-	-
Performance indicators	-	-	-

The only reference to spatial planning worth mentioning appears as a strategy to define thermal electricity generation plants location in order to take the most out of the resources used while minimizing air pollution.

As a whole, the Scottish document is underwhelming regarding the spatial planning approach, considering it barely mentions it, while concerning the water focus, although there aren't many references to it, the ones mentioned reveal some awareness to the relevance of the matter.

4.4.3 A Circular Economy in the Netherlands by 2050

The Dutch document has many references to both water and spatial planning, with the first receiving the most attention with twenty-eight references. Starting the analysis with water, the results are displayed in table 6 (total references in appendix 5).

Table 6 - Water references in the Dutch document.

Topics	Number of references	Quotes and pages	Description
Problem showcase	6	"By preventing pollution with circular products and services, we will save money spent on water purification and, over time, save on the costs of clean-up and health. The fact that this can yield not only an environmental benefit, but also an economic benefit is demonstrated by the Dutch invention of dying textiles with CO2. This invention is now increasingly being used by textile and shoe producers worldwide. This method replaces water – traditionally used in the dying process – by CO2. This reduces raw material requirements, cuts back the use of water, energy, and chemicals, and eliminates the cost of purifying wastewater to be released." (Page 12)	Reference to the economic benefits of a circular approach concerning raw materials. Also gives the example of an innovation in textile industry.
		"A major challenge with respect to plastics is reducing the dependency on fossil resources. In addition, large volumes of plastic end up as litter, which does not belong on the streets or in the oceans. One property of plastic is that it takes a long time to degrade, or it hardly degrades at all. In water, plastic gradually degrades into increasingly smaller (micro and nano) particles. These particles – that can attract toxins – eventually affect the ecosystem and end up in our food system (through, for example, birds and fish)." (Page 51)	One of the problems associated with lack of treatment and management of waste.
Objectives	4	"In a response to the WRR [Dutch Scientific Council for Government Policy] report Towards a food policy, the Cabinet presented its views on food policy to the House of Representatives on October 30th, 2015. In its response, the Cabinet indicates to pursue an ecologically sustainable food system in which raw materials, energy, water, and nutrients are utilised economically and efficiently, the preservation of natural capital is taken into account, and natural capital is used in a sustainable manner. This means that the quality of soil, water and air is protected, and biodiversity is maintained, while at the same time reducing greenhouse gas emissions." (Page 43)	Objective to improve the food system in response to a report related to that matter.
		"By 2050, the construction industry will be organised in such a way, with respect to the design, development, operation, management, and disassembly of buildings, as to ensure the sustainable construction, use, reuse, maintenance, and dismantling of these objects. Sustainable materials will be used in the construction process, and designs will be geared to the dynamic wishes of the users. The aim is for the built-up environment to be energy-neutral by 2050, in keeping with the European agreements. Buildings will utilise eco system services wherever possible (natural capital, such as the water storage capacity of the sub-soil)." (Page 59)	A set of goals to the construction industry that will focus on using eco system services (hence the reference to water, in water storage capacity).

Table 6 – Continuation.

Topics	Number of references	Quotes and pages	Description
Measures and strategies	13	"There is an extreme imbalance between the short life span of textiles and the permanent impact these materials have. We use mainly textiles that are no longer suitable for wear (70%) and process them in a smart process – without the use of water or additional chemicals, which yields yarn and textiles with a considerably better ecological footprint!" (page 18)	Innovative process that recycles old textiles, saving more water than if it was made from scratch.
		"By gradually scaling up the standards to establish, say, full circularity with respect to emissions to land, air and water, companies will be forced to innovate and adopt circular substances and technologies." (Page 23)	Reference to an enforcement of innovation by scaling up the standards.
Stakeholders analysis	5	"The EU is an important source of funding for research and innovation for the circular economy (Horizon2020 and LIFE). For the budget years 2016 and 2017, Horizon2020 has allocated approximately 650 million euros to circular economy projects, including funds for large demonstration projects aimed at closing the loop in the raw materials and water cycles, funds for regional development projects, and funds for the development of new business models." (Page 36)	Reference to the role of the EU as an important fosterer of the circular economy.
		"In recent years, the Netherlands has established an international reputation as a frontrunner in the circular economy, with knowledge and experience in the areas of waste and nutrient management, technological and social innovation, an integrated approach and cross sectoral cooperation with companies, knowledge institutes, and governments. Dutch companies are international leaders in the fields of water, agriculture, maritime activities, logistics, and governance, and presenting integral solutions." (Page 38)	Reference to the relevance of cooperation between several entities, from industries, to knowledge institutes and the government.
Performance indicators	-	-	-

So analyzing the table 6, regarding water references, just like with other previous documents, the bigger focus is on the "Measures and strategies" topic, with twelve references, meaning there are plans to actually change things in the water sector, in the context of circular economy. But other topics also got a large and somewhat evenly distributed amount of references, with the only exception being the "Performance indicators" that got none.

Starting with the "Problem showcase", the first reference mentions the benefits that can be reaped by preventing pollution and the fact that by doing so it is possible to not only protect the environment, but also get economic gains. And comes with an example of an innovative measure adopted by the textile industry, which replaced water by CO2. The second reference is about the consequences of a poor management of plastics, although the same principle applies to almost every single material in

our current society. The second topic, the “Objectives”, approaches the goals to make changes in two sectors, being them the food and the construction sector. Both of them consume large amounts of resources in the production phase, and produce large amounts of waste after use, making them great candidates for change. Next comes the “Measures and strategies” topic, which as said previously, has the largest number of references, with the main focus being on innovation and legislation, and also how both of them can be linked to one another. Considering that innovation plays a major role as a fosterer of a circular economy, legislation can work as a fosterer of innovation by establishing new and higher standards or by leading the way to specific goals. Lastly, the “Stakeholder analysis” mentions the importance of large entities and also the connections between stakeholders from all areas. Innovation requires time and money, the transition to a circular economy more so. And large institutions, like the EU in this case, can provide the means to do so by financing and supporting all kinds of stakeholders. And on the other hand, the connection between stakeholders and the ability to share knowledge and resources among them, no matter their area of expertise, can dramatically improve the speed and efficiency of the transition to a circular economy.

Concerning spatial planning, the Dutch document has nine references to it, as registered in table 7 (total references in appendix 6), nearly evenly split between the three middle topics, with the first and last topics, “Problem showcase” and “Performance indicators” respectively, not getting any.

The first references are in the “Objectives” topic, and approach the built environment, and the enhancements that need to be made, through spatial planning, to improve the life of the citizens, and the way that ecosystems and biodiversity can be protected by including them in national and local planning processes. Then comes the “Measures and strategies” topic, in which several measures with spatial planning at their core are evidenced as a support for circular economy activities in one reference, and in the other the focus is on a program developed with the single purpose of finding solutions to bypass problems to the stakeholders regarding legislative barriers, either by adapting the legislation or supporting the stakeholders in other ways. Lastly, the “Stakeholders analysis” addresses the importance of communication between the authorities and the fact that even entities with different scopes can and should work together.

Table 7 - Spatial planning references in the Dutch document.

Topics	Number of references	Quotes and pages	Description
Problem showcase	-	-	-
Objectives	3	Make cities and human settlements inclusive, safe, resilient, and sustainable (e.g., through inclusive and sustainable urban development and building capacity for participative, integrated and sustainable planning); (Page 7)	A set of goals related to a circular approach for the urban environment.
		Protect biodiversity and ecosystems (e.g. by integrating ecosystem and biodiversity values into national and local planning and into development processes). (Page 7)	A goal to protect natural systems through spatial planning (in the context of a circular economy).
Measures and strategies	4	"The Netherlands Environmental Assessment Agency (PBL) indicates that spatial planning solutions can also contribute to the transition to a circular economy. This also comprises the connection with the natural capital policy field. Through business park management and urban planning, companies in industrial parks can make use of one another's materials and residual streams, as shown in Park20|20 in Haarlemmermeer. At the local level, loops are then closed. Regional spatial planning policy offers greater scope for supporting circular activities. The Cabinet aims to develop projects with pioneering cities for the adaptation of local area planning, such as disconnecting rainwater collection in new construction and installing green roofs." (Page 18)	Several strategies focusing on spatial planning as a tool able to assist the transition to a circular economy. Among the strategies are industrial symbiosis, green roofs and others.
		"The Smart Regulation programme (Ruimte in Regels) runs up to 2020. In this programme, the government cooperates with entrepreneurs to look for greater room within current legislation to promote sustainable innovations. The programme was initiated following indications from entrepreneurs who felt restricted by legislation when planning innovative investments. The Smart Regulation programme delves into the nature and background of these barriers, brings the relevant parties together and helps them to search for solutions." (Page 24)	A programme created with the purpose of adapting current legislation to meet innovative concepts requirements.
Stakeholders analysis	2	"The national government and regional authorities in the north and south wings of the Randstad and Brainport Eindhoven signed a declaration of intent on 9 June 2016 to establish a spatial economic development strategy (ruimtelijk-economische ontwikkelingstrategie, REOS). This collective strategy is intended to help these regions to remain internationally competitive." (Page 21)	Reference to the importance of communication and assistance between the regional and national governments.
		"The Cabinet will support a circular economy through spatial economic policy that fits in with current initiatives. To optimally deploy the strength of partnerships at various scale levels within the Netherlands in the transition to the circular economy, an integrated toolbox has been developed that will actively be offered to stakeholders at the regional level." (Page 21)	A specific set of tools developed to help stakeholders at a regional level.
Performance indicators	-	-	-

Overall, with thirty-seven references, the Netherland's document shows that both water and spatial planning are seriously taken into account and the plans for the transition to a circular economy in the country can't move forward without these two subjects.

4.4.4 Circular Economy - Denmark as a circular economy solution hub

The Danish document has the lowest number of pages of all documents analyzed, and by a large difference. That being said, it's somewhat natural that the number of references to water and spatial planning is lower than the remaining documents, although the latter is not mentioned at all. That being said, the references obtained for water are displayed in table 8 (total references in appendix 7).

Table 8 - Water references in the Danish document.

Topics	Number of references	Quotes and pages	Description
Problem showcase	2	-	-
Objectives	-	-	-
Measures and strategies	3	"Increased focus on resource efficiency has resulted in innovative Danish clean-tech solutions and expertise that are exported widely on the global market, such as energy-saving pumps and water-efficient solutions." (Page 16)	The focus on circular measures, specifically resource efficiency, lead to innovative solutions that are now valuable assets.
		"Investments in the value chain, such as breeding of animals, new effective stables, feed optimisation, recycling of nutrients, as well as improving energy and water efficiency, logistics and utilisation of side-streams, are interconnected." (Page 19)	All areas share a connection and improving one, means that other will also be affected.
Stakeholders analysis	1	"State of Green is a public-private partnership founded by the Danish Government, the Confederation of Danish Industry, the Danish Energy Association, the Danish Agriculture & Food Council and the Danish Wind Industry Association. H.R.H. Crown Prince Frederik of Denmark is patron of State of Green. As the official green brand for Denmark, State of Green gathers all leading players in the fields of energy, climate, water, and environment and fosters relations with international stakeholders interested in learning from the Danish experience." (Page 23)	The importance of connecting several stakeholders, from several areas and fields of expertise.
Performance indicators	-	-	-

Analyzing water as shown by table 8, the “Problem showcase” topic, although it has two references, none of them were relevant and didn’t add any useful information to the analysis, so no quote was mentioned. As for the following topic, the “Measures and strategies” addresses the way that the focus and need for change propelled progress and lead to new solutions in the field of resource efficiency, and also the link between the several areas of circularity, in which a change in one of the links will almost invariably affect all the others. And for last comes the “Stakeholders analysis” highlighting the importance of the connections between several stakeholders from different fields to share their expertise and knowledge.

With just six references to water and none to spatial planning, the Danish document doesn’t have an extensive list, containing many different approaches, nor it would be reasonable given the size of the document, but still addresses some relevant matters.

4.4.5 Leading the cycle - Finnish road map to a circular economy:

On a first notice, as the Finnish document was divided in chapters, subchapters and sub-subchapters, the latter were placed between brackets, in front of the subchapters, for a better organization of the table present in the appendixes. That being said, the Finnish document has a moderate amount of references to both water and spatial planning, with the first still getting the advantage.

Starting the analysis with water, the information gathered is shown in table 9 (total references in appendix 8). The first topic of the “Problem showcase” highlights the focus of sustainability of circular economy concerning resources use, with water being directly mentioned as one of those resources, thus emphasizing its importance. Then comes the “Objectives”, with the focus going from the several areas that will be addressed through new projects, to the example of how an improvement on one kind of transportation could represent some drastic changes in the overall sector, and also how the connections between stakeholders are a great driver for improvement, both individually and collectively, and need to be fostered. As the last reference, in the “Measures and strategies” topic, a set of examples is given that are line with circular economy and should be adopted by the overall industries (if possible) as more efficient and environmentally friendly measures.

Table 9 - Water references in the Finnish document.

Topics	Number of references	Quotes and pages	Description
Problem showcase	3	"A circular economy uses the earth's limited resources (metals, minerals, energy sources, water, timber stocks, rich soil, clean air and biodiversity) in a sustainable manner." (Page 45)	A brief description of the amount of areas that a circular economy can affect.
Objectives	3	"The goal of the Smart & Clean project is to create a low carbon and smart transport and mobility export concept for Finland. Over a 5-year period, 20-30 significant project entities will be created, with the themes of transport, construction, energy, waste and water sector and consumer cleantech." (Page 27)	The goal to improve a considerable number of areas through new projects.
		"Making water transport in the Saimaa region a resource-efficient alternative to land transport. The goal is to find concrete methods that would make water transport in the Saimaa Canal and Vuoksi waterways a potential alternative to transport by land while still preserving the sensitive lake environment." (Page 29)	Improvement in one area of transports could mean more competition and more environmentally sound options.
		"From waste to energy and bioenergy. Mainly developing markets. The goal is to speed up and increase the international growth of companies throughout the industry value chain (raw materials, energy production and biofuels), primarily by means of export. The Finnish offering will cover the entire scope, from small off-grid solutions to large, centralised solutions. The aim is to identify entities and develop joint projects to provide more extensive coverage of the value chain. The increased global need for energy, food and water will spur growth in this sector." (Page 33)	The relevance of the relations between stakeholders is evidenced as a way of developing new projects and further boost their own businesses.
Measures and strategies	4	"Refining bio-based raw materials into products with a higher refinement value, increasing product biodegradability and recycling and using more environmentally-friendly production methods instead of production processes that consume a lot of water, energy and raw materials all support circular economy targets." (Page 21)	Set of measures that contribute to a circular economy.
Stakeholders analysis	-	-	-
Performance indicators	-	-	-

As for the spatial planning references, shown in table 10 (total references in appendix 9), they are either a sort of introduction to the matter or a set of measures to foster circularity. Starting with the "Problem showcase", the first reference addresses the problem of the construction sector and the amount of waste generated during construction and after its life cycle has ended and how spatial planning could minimize this problem. The second reference also addresses buildings, but this time about their management during the utilization period of its life cycle, which, when properly handled, could represent great economic gains with minimal waste production. The last topic with references is

"Measures and strategies" and the first one is about a project that pretends to include ecosystem services and natural capital into land use planning and natural resource use, thus creating a single uniformized system and facilitating their management, while the second is a reference to a set of strategies to foster transport change.

Table 10 - Spatial planning references in the Finnish document.

Topics	Number of references	Quotes and pages	Description
Problem showcase	4	"Construction uses a huge amount of materials and masses for different products and surfaces. Choices of materials and products affect a building's service life and how it can be refurbished. In terms of the circular economy, town planning is the first decisive phase, because it can, for example, be used to steer construction efficiency and material choices. On the other hand, building and project planning can steer material flows at the work site, such as using masses at another work site, using excess material, minimising waste, using any demolition waste, etc. Realisation of this requires town planners, permit authorities, designers, customers and implementers share a commitment to anticipation." (Page 25)	Spatial planning, or in this case, town planning can affect buildings' life and decrease residues when it comes to an end, revealing itself as an invaluable tool for a circular economy.
		"In the Helsinki area alone, there are currently 1.25 million m2 of empty office space which cannot currently be converted for residential use because of planning regulations. Assuming that a third of this space could be converted by 2030, measured in rental income the value of such a conversion would be around EUR 255 million a year. The national economy would also save close to EUR 700 million if the costs of conversion were compared to the costs of new construction." (Page 25)	The result of bad planning, and consequently, potential for a lot of improvement in the context of a circular economy.
Objectives	-	-	-
Measures and strategies	2	"Intangible value creation is a key factor in the circular economy, so strong integration and commercialisation of ecosystem services will open up new business opportunities. OpenNESS is a European research project that wants to link the concepts of ecosystem service and natural capital with the planning of land use and natural resource use. The project offers tested, practical and tailored methods for integrating ecosystem services into different sectors. The international project investigates how the concepts link to and support EU policies. It also assesses which factors will enable or prevent the maintenance and continuity of ecosystem services in the future." (Page 21)	Reference to a project that wants to integrate ecosystem services into urban planning, creating a single uniformized system.
		"Among others, the following methods can promote the transport change:" "… promoting a transport change by means of land use, transportation and housing agreements (LHT Network); increasing the number of parking places for shared cars by means of flexible town planning and developing the related co-operation;" (Page 26)	A set of measures able to improve the transport sector.
Stakeholders analysis	-	-	-
Performance indicators	-	-	-

Overall the Finnish document has sixteen references to both water and spatial planning, enough to reveal some awareness to their relevance for the transition to a circular economy, but not enough comparing to other matters focused throughout the document.

4.5 DISCUSSION OF RESULTS

The first noticeable aspect is that, just like what was evidenced by the literature review, none of the documents linked water and spatial planning in the context of a circular economy. All the documents addressed water to some degree, most also addressed spatial planning, but none of them linked the two. This evidences a clear lack of exploration of the matter, either because it was deemed not relevant enough or possibly not considered at all. Another relevant aspect is that one of the selected topics, the "Performance indicators" had no direct references whatsoever linked to either water or spatial planning, meaning that even if strategies are being implemented and measures are being adopted, there is no planned method to evaluate if they are producing the desired results or actually doing more harm than good.

Moving on to another subject, and as evidenced by the first analysis resorting to *WebQDA*, the amount of references to water and spatial planning are, in most cases, reduced in number. With the exception of the document from the Netherlands, that contains more than thirty references between water and spatial planning, all others have less than twenty, with some even being below ten. This fact also confirms the tendency evidenced by the literature review in which it was demonstrated that although the circular economy subject has been exponentially expanding in the last decade, the water focus represents only a small fraction of it and spatial planning is barely even considered.

Another highlight is related to the information contained in figures 7 and 8 (page 39). Those five topics indicate the focus of each reference and since the majority of references is under the "Measures and strategies" topic it is possible to state that water and spatial planning are mentioned on planned actions or strategies that are either already underway or soon to be implemented. The second topic with most references, "Problem showcase", indicates the amount of times water and spatial planning are mentioned identifying issues on both fields, while the third most mentioned, the "Objectives" topic, identifies situations where water and spatial planning are mentioned in plans or goals for the future. "Stakeholders" references are scarce and "Performance indicators" are inexistent.

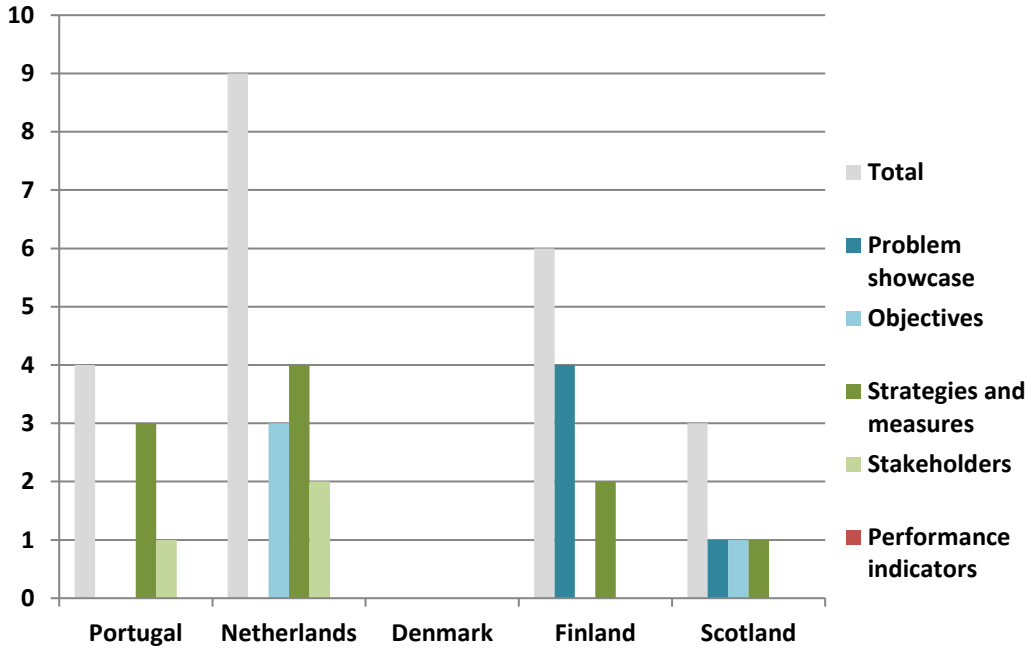

Figure 7 - Spatial planning references distribution for the selected national plans.

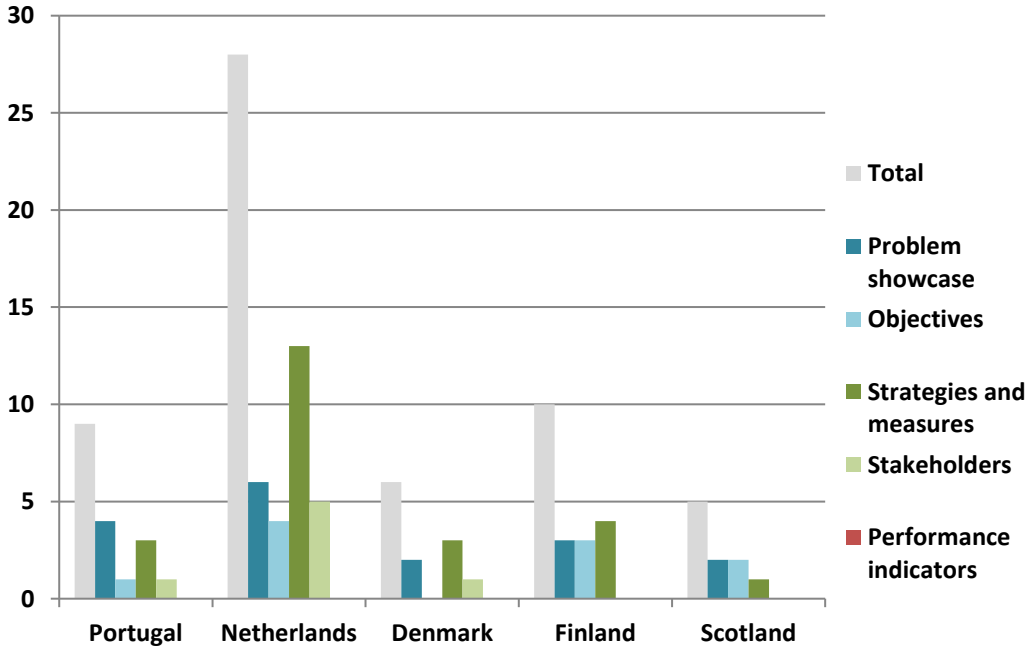

Figure 8 - Water references distribution for the selected national plans.

On another subject, as stated by Frank & Marsden, (2016), the scale at which spatial planning is considered can have different impacts on different areas. A national plan setting the guidelines for the transition to a circular economy, as are these four documents analysed, should already address issues like transportation and even the role of local authorities as evidenced by Mattila, (2016) on the case of Forssa. And even if some documents address these issues to some extent, the fact that this isn't a common focus is, by itself, something to be highlighted. As for water, the results also evidence that the statement from Abu-Ghunmi et al., (2016) is all but groundless, as for all the documents, water received considerably less attention than other matters. On a positive notice there is the extraction of resources from waste-waters, a relevant matter as stated by Puyol et al., (2016) and an issue addressed frequently by most of the documents and that represents a great opportunity for recovery of nutrients, energy while improving water quality.

4.6 Conclusions

While the number of references is low, as evidenced, their content approaches some interesting and quite relevant matters. For water, the need for innovation is evidenced in many ways and the ways to promote and achieve it even more so. Whether through legislation, by committing to some objective or due to the exchange of ideas and knowledge between stakeholders, innovation is promoted as an essential part of a circular economy that can lead to more efficient processes and overall improvement to all areas. And if legislation and stakeholders' relations can lead to innovation, they can also produce other results on their own. Legislation can limit or assist the role of the stakeholders depending on how it's managed, while stakeholders can create circular hubs on their own through industrial symbiosis. As for spatial planning the results are similar, with innovation always playing a major role, but with governments from local to international, being the entities with the highest influence.

The distribution of the references also evidences a proactive approach as much of the contexts identified refer to actions and strategies already implemented or underway, meaning these plans focus not only on the future, but also the present.

Table 11 contains a short summary of the most relevant factors identified through the analysis of the five national documents, with a small description of the reasons they were selected.

Table 11 - Most relevant factors identified in the national documents.

Topics	Factors identified	Description
Requirements	• Collaboration between stakeholders;	• Sharing can only happen with agreements between stakeholders;
Actors	• Local, regional, national and international governments; • Industries; • Water utilities • Knowledge institutes;	• Governments are the law makers, the ones that can single-handedly drive change; • Industries, as producers and consumers, are the most interested in changes (especially if economically advantageous); • Water utilities are directly responsible for the management of water; • Knowledge institutes objective is to find new information/improve the existing, thus moving towards innovation;
Barriers	• Legislation; • Economic factors; • Technology;	• Legislation can halt progress whether by being too soft or too strict; • A circular economy transition requires investment in research, new equipment and infrastructures, which is not always easily accessible; • Several processes cannot be applied because there is no technological equipment able to do it, or not efficiently enough;
Drivers	• Innovation; • Legislation.	• Innovation leads to progress, to the development of more efficient and better practices; • Legislation can promote a sustainable development by setting progressive yet fair requirements.

A noticeable aspect regarding the findings from the analysis of the national plans is the similarity between them and the findings from the literature review. It's an aspect to be expected since the purpose of both documents is to address the transition to a circular economy, but it indicates that the problems identified are being worked on by the governments and the drivers are also being fomented as promoters of a circular economy.

4.7 National Program for the Efficient Use of Water

Since one of the focus of this study is the analysis of how water is being addressed in the Portuguese context for the transition to a circular economy, the document setting the guidelines for the efficient use of water is an indispensable source of information, even if circular economy is not directly mentioned at any point.

4.7.1 Introduction

The National Program for the Efficient Use of Water is a document, published in June of 2012, that sets the guidelines for an improved management of water for the present but with future impacts in mind as well. The program arises from the need to properly evaluate the state of water supply, use, and all the steps in between, in order to improve its efficiency, but also with the goal to prevent droughts or at least minimize its consequences when it happens.

4.7.2 Analysis

The document starts by exploring the water use by sector, with the three major sectors being analyzed: urban, industrial and agricultural, and presents the results both in absolute quantity (volume, figure 9) and relative use (percentage, figure 10).

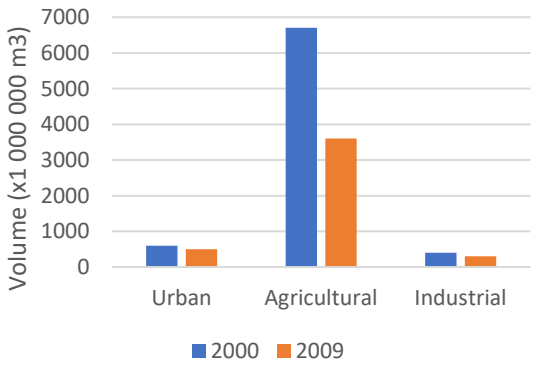

Figure 9 - National water use, by sector, in 2000 and 2009.

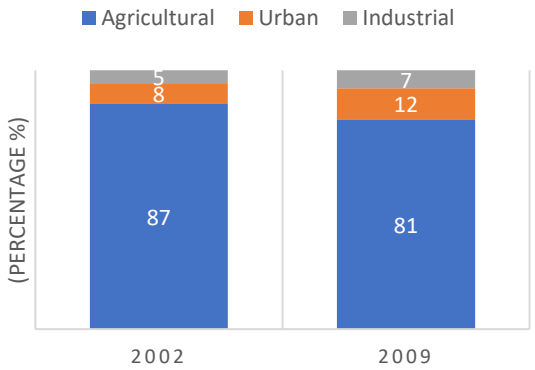

Figure 10 - Relative water use, by sector, in 2000 and 2009.

Note: In 2000, 100%= 7.5×10^9 m^3 and in 2009 4.2×10^9 m^3.

Source: National Program for the Efficient Use of Water (Programa Nacional Para o Uso Eficiente da Água).

The data shown also contains a comparison for two years, 2000 and 2009, and this is where the first noticeable aspect is evidenced. In the year 2000 the total water used was around 7.5×10^9 m^3, with

almost $7.0x10^9$ m^3 being related to the agricultural sector, while in 2009 the total amount of water used decreased to about $4.2x10^9$ m^3, with near to $3.5x10^9$ m^3 corresponding to the water consumption of the agricultural sector. In terms of percentages it went from 8% for urban sector, 5% for industrial sector and 87% for agricultural sector to 12%, 7% and 81% respectively. This improvement is justified, in the document, by a number of factors related to the national conjecture, which lead to a reduction of the irrigated areas, and on the other hand, the increased efficiency of water use, both in the reduction of losses from storage systems, transport, distribution, and the improvement of techniques used to irrigate the fields. Another aspect that also contributed was the drought registered between 2004 and 2006 which lead to a temporary reduction of irrigated areas.

The application of the above mentioned measures to the agricultural sector, combined with a set of measures applied to the remaining two sectors, originated a decrease in the wasted water through the years. If in 2000 the wasted water for the urban sector was 40%, the agricultural sector another 40% and the industrial sector 30%, by 2009 the waste had decreased to 25%, 37.5% and 22.5% respectively. The inefficiency related to the catchment and distribution of water was easier to account for the urban sector, thus the higher improvement among the three. In spite of the large improvement, the fact that all three sectors have an inefficiency of over 20%, and the agricultural sector, the one responsible for 80% of the water used, still has an inefficiency of 37.5%, cannot be overlooked and there are many opportunities to improve these numbers.

Another topic addressed by the document is the connection between water and energy and the fact that one cannot be dissociated of the other. To better demonstrate that, the number of examples given is significative and they are quoted below:

Water for energy:

- Thermoelectric cooling;
- Hydroelectric production;
- Mineral extraction and mining;
- Fuels production;
- Emissions control;

Energy for water:

- Pumping;
- Transport;
- Treatment;
- Desalinization.

Given this connection between water and energy, the associated costs with water for the energy sector and energy for the water sector will also vary accordingly to the changes to either of them, resulting in impacts to the socioeconomic structure.

As relevant as it is, the connection between the above mentioned sectors is just another example of the need for a program that clearly defines a framework for the efficient use of water, integrates all fields and promotes socioeconomic growth while also safeguarding the quality and future of the hydrological resources. The document highlights the following as the reasons for the need to improve hydric efficiency:

- Environmental imperative – water is a limited resource which should be properly managed to ensure the sustainability of all the systems connected to it;
- Strategical need – improving the availability and water reserves of the country is of the utmost importance;
- Economical interest:
  - Water waste also means money waste;
  - Water is important for production;
  - Water utilities allow for better management of investments;
  - Consumers allow to minimize water expenses;
- Obligation of the country – national normative and communitarian;
- Ethical imperative – water is absolutely vital and needs to be managed taking into account future generations.

4.7.3 Breaking down by sector

As a whole, the National Program for the Efficient Use of Water aims to improve the efficiency of water use without hindering the needs and quality of life of the population, aims to reduce the pollution of

water masses and also the energy consumption, aims to properly manage this resource so that droughts have their effects mitigated. Overall, it aims to introduce a new mentality on water for Portugal, so that this resource is properly valued in its human and economic aspects and a sustainable approach is always taken into consideration. But how can each sector contribute for these goals? To answer this question the document sets the goals for each sector first with a broader focus, but also with more specific areas of approach, and then gives an extensive list of concrete measures, applicable to two different fields, technological and behavioral, that could improve the approach on water by the sectors. There are 87 measures mentioned, with 50 for the urban sector, 23 for the agricultural and 14 for the industrial, with some examples withdrawn from the document displayed in tables 12, 13 and 14, respectively.

Urban Sector

This sector's main goal is to reduce water losses in the supply system and to achieve that it has a number of specific objectives:

- Improve water supply managers and consumers knowledge on the matter;
- Sensitize the main users and children for the subject;
- Improve the public water infrastructures by introducing measuring and control systems;
- Apply large efforts to the public systems and places where the costs are not supported (directly) by the population (schools, shopping centers, hospitals, among many others);
- Reduce potable water use for activities that can perform identically with lower quality water;
- Promote the use of normalized and certified equipment for the efficient use of water;
- Deliver awards and official recognitions to equipment, facilities and systems that prove to add useful resources for the efficiency of water use.

Table 12 - A few examples of measures for the urban sector.

Urban	
Measure	**Brief description**
Optimization of equipment	Reducing water consumption by using more efficient equipment
Use of treated waste water	Use of treated waste water for proper activities
Thermic isolation for hot water distribution	Reduce bath water waste until the ideal temperature is attained
Reutilization or use of lower quality water	Reutilization of bath water for toilets or similar cases

Agricultural Sector

The general goals for this sector consist on reducing the losses for the transport of water and the overall amount of water used for irrigation, but also adapting the tariffs associated to the water cost and volume of water used. To achieve this a set of specific goals have been defined:

- Improve the quality of projects for irrigation;
- Reduce the losses in storage, transport and distribution;
- Reduce the losses during the irrigation phase.

Table 13 - A few examples of measures for the agricultural sector.

Agricultural	
Measure	**Brief description**
Optimization of irrigation techniques	Replacing gravity irrigation systems for sprinklers
Adapt tariffs	Use tariffs by volume and ranks
Reduce losses in transport and distribution	Improve networks and canals to avoid leaks and loss of water

Industrial Sector

For this sector the main objectives consist on optimizing the water use without hindering the overall efficiency of the processes that depend on water, but also limit the environmental impacts associated to waste water discharges. To accomplish these objectives the following more specific goals have been set:

- Reduce water consumption and the volume of waste water generated by adapting procedures, using more efficient equipment and applying water reutilization/recirculation processes;
- Reduce losses in the distribution system;
- Improve factory processes to use less water;
- Use water of lower quality to cool down and wash equipment;
- Improve user habits in order to use less water;
- Retrieve steam generated in the heating systems.

Table 14 - A few examples of measures for the industrial sector.

Industrial	
Measure	**Brief description**
Use of waste water	Use waste water of the unit itself, after proper treatment
Dry clean equipment	Dry clean equipment instead of using water
Optimize processes	Use more efficient processes in order to save water

With the achievement of at least some of these goals, the document states that the waste of water should decrease to 20% for the urban sector, 35% for the agricultural sector and 15% for the industrial sector by 2020. However, since the improvement registered has been better than expected, there are plans in motion to identify the factors that contributed to that improvement and the goals and target plans should be adjusted to the new reality.

4.7.4 Implementation and Monitorization

The program started being applied in 2012 and it should go on until 2020, when the most likely scenario is an evaluation of the progress, followed by the elaboration of a new program. The implementation phase will cover, essentially, four fields: "Measurement and reconversion of water using equipment; Awareness, information and education; Documentation, formation and technical support; Technical regulation, normalization, labelling and certification". The first covers the loss monitorization e technological reconversion by the water utilities, industrial consumers, agricultural, domestic, collective and individuals. The second will focus on the creation and consolidation of a new mentality regarding the approach on water for all the sectors. The third will link all the relevant entities and create a supporting basis for the implementation of the technical aspects of the NPEUW (National Program for the Efficient Use of Water – *Programa Nacional para o uso Eficiente da Água*), and the last will address the manufacturers, distributors and merchants to set specific requirements for the equipment used by them and also manage the application of labels and certification to products.

The coordination for the implementation of the NPEUW is of the responsibility of the Ministry of Agriculture, Sea, Environment and Spatial Planning through the Portuguese Agency of the Environment, with the involvement of many other entities associated with the different sectors. To properly monitor and evaluate the implementation of the program all the entities shall meet twice a year, using the opportunity to better articulate the connection between sectors.

The monitorization and evaluation will be conducted by the Commission for the Implementation and Monitoring, through the application of a system of indicators that will measure the efficiency of the program; the monitoring of the processes being executed; public participation indicators and external and internal communication plans to evaluate the interaction between single and collective agents. Some examples of measures and efficiency indicators are the following:

Urban Sector

General indicators:

- Definition and implementation of procedures for monitoring and accounting the water consumption, with periodic analysis of consumption;

- Characterization of water usage: authorized billed consumption and authorized non-billed consumption.

Efficiency indicators:

- % of water extracted vs used water;
- Domestic consumption *per capita*;
- Urban consumption *per capita*, per system.

Agricultural sector

General indicators:

- Benchmarking of irrigation consumption by type of culture;
- Rate of application of the actions defined in the ProDeR (*Programa de Desenvolvimento Rural* – Rural Development Program).

Efficiency indicators:

- % of water extracted vs used water (for large irrigation areas);
- Unitary consumption (ha/year), by culture and region;
- Global unitary consumption (ha/year) by system and type of culture.

Industrial sector

General indicators:

- Adaptation of the mandatory yearly environmental reports to include explicitly the quantitative and specific water use indicators;
- Extension of the annual industry inquiry by INE (*Instituto Nacional de Estatística* – National Statistics Institute) to the use of water.

Efficiency indicators:

- % of water extracted vs used water;
- Unitary consumption by product (m^3/ton);
- Unitary consumption by factory (m^3/ton produced).

4.7.5 Economic Impact

Assuming that the first estimates are reached and the implementation of this program reduces the water inefficiency from 40% for the urban sector, 30% for the industrial sector and 40% for the agricultural sector to 20%, 15% and 35% respectively (from the 25%, 22.5% and 37.5% registered presently), and considering the direct economic benefit resulting from the losses prevented being 1.46 €/m^3 for the urban sector, 0.73€/m^3 for the industrial sector and 0.55 €/m^3 for the agricultural sector, the overall economic benefit would be 101 million euros (38.5 for urban, 47.3 for agricultural and 15.9 for industrial).

4.7.6 Conclusions

The National Program for the Efficient Use of Water sets the frameworks for the reduction of water loss and the overall optimization of the water system and, as such, is an invaluable asset for the protection of the hydric resources, even more in a country often affected by droughts.

The program addresses the issues affecting the industrial, urban and agricultural sectors in a sustainable manner, articulating and connecting all of them as much as possible. All the sectors show a significant improvement from the latest set of measures, even more than what was expected, however the one that would have the larger impact due to the sheer amount of water used is also the one expected to improve less, as the agricultural sector should go from the initial 40% to only 35% of water loss. This evidences the difficulty of improvement for this sector, however it is also a reminder that no matter how much has been done, there is still a long way to go. Still, and speaking now of the financial aspect, improving the inefficiency from the initial to the predicted values would already represent about 100 million euros in savings yearly, a substantial amount, even more considering the financial crisis faced by Portugal in recent years.

Speaking of economy, although there is not a direct mention to circular economy or circularity in any way, all the matters addressed in the document fit within the circular economy ideals as a sustainable approach that focuses on extending the life cycle of the resource by preventing its contamination, using it in a closed loop, downgrading the requirements for the water used or plain and simply reducing the amount of water used. Given the extension of the measures applied and the areas they are applied to, the effort required to successfully and efficiently implement this program is massive and at many levels,

however, the rewards for both the economy and the environment justify and must be an incentive in that direction.

5 Water Circular Economy in Portugal

In order to assess the current state of the transition to a circular economy in Portugal, one of, or even the most valuable source of information comes from the experts responsible for such task, that are actually working on the matter and have a prime position experience wise. However, and bearing in mind the scale at which the circular economy matter is handled, it's not easy to establish a few experts to contact and to get insight from. This is where both the literature review and national plans analysis come in, providing useful information on the entities and their work regarding the subject and the relevance of each for the transition to a circular economy. That being said, the results evidenced that the government (at national, regional and local level), the knowledge institutes, the water utilities and the industries have the highest influence concerning the matter and, as such, all the contacts made were in an attempt to reach people from the mentioned entities, with the exception of the industries. This exception was due to the nature of the work done by these entities, since most private industries are usually reticent about sharing information regarding their private policies, measures and even more about future plans, and also due to the vast number of fields in which industries can work on (specifically involving water) that would make the relevance of the results extremely subjective. A set of structured interviews were conducted with a member of the Ministry of Environment, a professor of environmental engineering of a University, two professors of civil engineering, a president of a water professional association and a technician of a water utility.

5.1 Enquiry Results

The contact with the selected entities was made via an interview whenever possible, and through a small questionnaire when the availability of the respondents was scarce. In order to compare the results under the same criteria the questions were the same to all entities, but with an attempt to make them as inclusive as possible. There were six questions total that are written below, with the answers immediately following them, identified as "A1" to "A6", without any particular order for the interviewees.

Question 1: "Are you aware of the existence of any symbiosis agreement between industries and water utilities responsible for the management of the urban water cycle in Portugal?"

A1: “Yes, with projects for the extraction of sludge to produce ceramics, nutrient extraction from wastewater, water reutilization for agriculture. However, industries usually prefer to reuse water internally, not having to deal with people outside of their service.”

A2: “Yes, for cooling.”

A3: “No.”

A4: “Not specifically.”

A5: “No.”

A6: “No. There are examples of reuse of waste-waters but within the industries of origin of those waste-waters or in partnership with municipalities or managing entities.”

Question 2: “Do you consider that the promotion of water circular economy solutions is compatible with the current planning system for the hydric resources, based on the Water Framework Directive, specifically the water quality goals and the water discharge rules? What barriers and challenges are faced by planning?”

A1: “Depends on how water is addressed (as a product, a resource or a utility). For products the rules of materials apply, for resources it is dependent on the domestic availability and as a utility the focus should be on the transport and discharge. The best course of action is, for all, to address the issues upstream.”

A2: “There is a need to review legislation, a challenge concerning the classification of materials (whether as waste or raw material) and there is a resistance from experts who want to avoid permissiveness.”

A3: “Challenges concerning the excessive requirements for water.”

A4: “They are not incompatible but the means for the transition to a circular economy are not guaranteed as the Water Framework Directive wasn’t even thought on that account. The plans for the hydric resources are developed to answer social, economic and environmental issues separately, so an interconnection would be beneficial, however complicated due to a lack of norms and procedures guiding that connection.”

A5: “Not incompatible but planning didn’t take into account circular economy. There needs to be a reformulation of the organization of water management entities and water system, particularly urban water.”

A6: “It is compatible with the Water Framework Directive concept, but lacks legislative and regulative framing.”

Question 3: “Do you consider that the current sanitation infrastructures existing in Portugal are prepared to adopt circular economy solutions? What kind of barriers need to be overcome?”

A1: “Technologically, any wastewater treatment plant can be converted into a bio-refinery. However, for municipalities, financing can be a problem.”

A2: “There are improvements to be made by planning for the locations of industries, building more wastewater treatment plants and adapting them with different levels of treatment. A barrier to overcome is the difference between the investment on the coastal area and the inland.”

A3: “Currently is possible to take advantage of the thermal energy produced by wastewater and there is also the opportunity to harness the power from water with elevated pressure through turbines.”

A4: “No. Nutrient recovery, water re-infiltration or other circular processes imply a different conceptualization of these systems that were designed and still work using water as a mean of transport and dilution.”

A5: “No but that doesn’t mean there aren’t circularity solutions. Change is not easy to achieve.”

A6: “At urban cycle and public networks level, the reutilization of treated waters is already a reality, however occasional, which shows that there is some framework. At the buildings level, the reutilization of water has high potential, particularly for collective use buildings, but lacks regulation. The performance of public networks and waste-water treatment plants must be assessed for the situation of a crescent reutilization in buildings.”

Question 4: “Do you consider that spatial planning can be a barrier to the promotion of water circular economy solutions? How? And how should the territorial plans be improved to better accommodate water symbiosis solutions?”

A1: “Spatial planning is a driver, hardly a barrier. Older spatial plans focused infrastructure’s issues, currently they focus on endogenous resources. There should be a better management of the location of industrial and agricultural areas, there are opportunities from the non-segregation.”

A2: “Urban solutions should be thought as a whole, not individually. Less differentiation between industrial and urban areas. More green spaces can help to control water problems.”

A3: “There is a need to integrate all the components instead of segregating industrial, urban and agricultural areas.”

A4: “Not at all. Spatial planning and territorial management could play a major role on water symbiosis because only through the articulation of territorial management mechanisms it is possible to close the loops. This requires an active role from municipalities and the Municipal Plans for Spatial Planning (*Planos Municipais de Ordenamento do Território – PMOTs).”*

A5: “Urban water cycle is deeply connected to spatial planning. There are two different perspectives, the inland and coastal areas. There needs to be political will and money. Water treatment on small waste-water treatment plants is somewhat cheap, but expensive for the populations.”

A6: “It is not a barrier, but most of the plans elaborated today still don’t have a proper framing of resource and energy use according to current knowledge and challenges. In fact, generally, spatial planning is still largely based on past century premises.”

Question 5: “What are the main regulatory barriers (for example connected to quality standards, water tariffs, concession contracts) that you consider that need to be thought for the pursuit of a circular economy?”

A1: “The mentality of the stakeholders should be taken into consideration as a factor that affects all the actions.”

A2: “Municipalities should enforce some rules (while also leading by example). Technologies need to be fully assessed and implemented by qualified people in order to not raise skepticism. Water needs to be controlled both up and downstream. There should be a separation of water by quality in every building.”

A3: “There is a considerable difficulty in managing tariff values to accommodate all kinds of consumers. There are also some barriers concerning the distinction between producer and consumer in cases where both scenarios coexist.”

A4: “An unidimensional tariff application and a linear understanding of water quality patterns is not compatible with a system that needs to create new concepts of “mean”, “end” and “supply source”.”

A5: “The existing regulation wasn’t planned taking into account circular economy. The main barriers are financial, public opinion and inappropriate water quality norms.”

A6: “Regulation is, by itself, the main barrier. The new General Regulation for waters and sewers, yet to be published, will create conditions for reuse at building level, although there are already small equipment (like sink combined with toilet) that allow for local reuse. Even though the document has been ready for a year, a lack of political will halted its publication.”

Question 6: “Which actors do you consider as most relevant for the transition to a circular economy in Portugal and what measures should be developed to reinforce it?”

A1: “Industries, municipalities and governments.”

A2: “Government, municipalities and universities. Small scale technologies should be exploited for specific areas instead of large scale for large areas.”

A3: “The government, which should focus on adapting the legislation whenever necessary, the universities and the general population.”

A4: “Municipalities, population and water utilities. Articulation between spatial planning mechanisms; adaptation of tariff’s regulation system; promotion of auditions and public participation on all reutilization, recovery and recycling measures and the better understanding of production cycles and consumption; clarification of concepts; organizational learning and public decision-makers formation.”

A5: “Government and industries. The measures are winning public opinion; development of new technologies and shifting the idea that circular economy is just for material waste.”

A6: “Water utilities, Municipalities and general population. The latter should be heavily involved, specially at buildings level, shifting the role from the governments to the population. The awareness of the citizens for water circular economy should be reinforced, particularly at younger ages.”

5.2 Analysis and Discussion of Results

The results obtained through the direct contact with entities in one way or the other responsible for the transition to a water circular economy in Portugal reveal some relevant issues regarding the barriers and challenges faced, but also give some insight for future prospects and the ways to achieve the circular goals for the country. The summary of the findings is displayed in table 15.

Table 15 - Summary of the factors identified through the contact with Portuguese entities.

Topics	Factors identified	Description
Requirements	• Collaboration between stakeholders; • Adequate mentality from the people and the stakeholders;	• Sharing can only happen with agreements between stakeholders; • No matter how good a measure is, if not accepted by the targeted audience it's useless;
Actors	• Local, regional and national governments; • Industries; • Water utilities; • Knowledge institutes; • Population;	• Governments are the law makers, the ones that can single-handedly drive change; • Industries, as producers and consumers, are the most interested in changes (especially if economically advantageous); • Water utilities are directly responsible for the management of the water systems; • Knowledge institutes objective is to find new information/improve the existing, thus moving towards innovation;
Barriers	• Legislation; • Economic factors; • Mentality; • Segregation;	• Legislation can halt progress whether by being too soft or too strict; • A circular economy transition requires investment in research, new equipment and infrastructures, which is not always easily accessible; • Industries tend to close themselves from outdoor contact as much as possible, which difficults sharing; • Segregation limits the existence of symbiosis and other beneficial relations across all sectors;
Drivers	• Innovation; • Legislation; • Spatial planning.	• Current technologies and strategies can be, in some cases, not efficient enough to make a certain project/activity viable, so new ones are needed to overcome this challenge; • Spatial planning has a major role to play by supplying the means to and connecting all sectors as one.

Starting with the first question, while most of the interviewees were not aware of existing cases of symbiosis in Portugal, which by itself already reveals that probably there are not many cases to begin with, the ones that were mentioned highlight the potential within the subject, with wastewater treatment plants being responsible for the production of sludge that will lead to the production, for example, of construction bricks at bio-refineries, and also the nutrients removed from wastewater can be reused, for example, as fertilizer for agriculture. And also the potential of interaction between industries and municipalities, with water used to cool down heating boilers and other similar equipment being used as a source of heat in the area near these industries.

The second question addresses the planning system for the hydric resources and the answers reveal many different thoughts on the matter, but also an opinion shared by most of the interviewees that although the two subjects are not incompatible, the Water Framework Directive did not take circular economy in consideration at the time of its elaboration, so some framework and regulation is required. Other subject is the classification given to water, as it can be seen as a product, a resource or a utility. In the first case, water is thought as any other product, meaning that it should be designed for durability throughout its many phases. In the second case, water should be managed minding the inflows and outflows of the process, always aiming for a sustainable balance in order to not deplete the resource. For the third case, as a utility, the focus should be on the transport and the final destination given to water in order to not undermine future utilizations nor negatively affect other systems. Whichever the best classification, all share one thing in common: the best course of action is to take measures upstream, meaning that it's always better to prevent water from getting contaminated or its quality reduced than to treat it back to decent standards. Other opinion highlighted the challenges faced due to the excessive requirements for water, particularly for activities where it would make no difference if the quality of the water was not at drinking standards (as long as it's not heavily degraded). Another interviewee addressed also the legislation challenge, which is not always on pair with the current scenarios, but it also pointed out an interesting topic and unmentioned so far, which is the transference of status. As mentioned in earlier chapters of this dissertation, industrial symbiosis consists, among many things, on making use of one industry's residues as another's raw materials. However, there are specific legislations for residues and other specific set of legislations for raw materials, and the transition from one denomination to the other can prove to be a challenge and further clarification is required from the responsible entities. The final mention is related to the experts' concern with

permissiveness, as the adaptation of legislation to better accommodate circular economy initiatives could also lead to “loopholes” to be exploited and cause more harm than the benefits they were intended to create.

The answers to the third question reveal that, while there are still many opportunities to be exploited, the current infrastructures existing in Portugal can already accommodate several circular measures without the need for massive restructuring and, in fact, already exist some cases at a low scale. This is evidenced by the possibility of converting wastewater treatment plants in biorefineries, extracting energy and nutrients also from wastewater, using high water pressure to produce electrical energy thanks to turbines. These measures require, in most cases, little adaptation regarding the physical infrastructures but they can still be rather expensive for the municipalities, which can prove to be a difficult barrier to overcome. Another problem for Portugal is the difference of investment between coastal and inland areas. Considering that most of the population lives in the coastal areas and most of the major cities are also along the coastal line, there is a higher investment in the infrastructures for those locations, in detriment of the ones located to the inner part of the country. A measure that could improve the wastewater management and also address the investment difference issue would be the creation of smaller, more specialized wastewater treatment plants. That way the effluents from urban and industrial sources would be handled at plants focused specifically on each kind of wastewater, not contaminating all wastewater with all the chemicals and nutrients from the different sources, saving money on treatments and making it easier to extract components from the water. This would also improve the inner land issue by requiring smaller investments and more adapted to the number of people to cover for each case.

For the fourth question there are two major points on which most of the the interviewees agreed to some extent, the first being the fact that spatial planning is above all a driver not a barrier, and the second is the fact that spatial planning to play its role efficiently it is essential that all areas, industrial, agricultural and urban, are considered as a part of an integrated system, and not segregate them as currently happens in most cases. Circular economy involves interactions between all kinds of stakeholders and planning ahead on how a specific industry can benefit a municipality or agricultural fields, or vice-versa, can be a major driver in the transition to a circular economy. And not only can spatial planning provide direct environmental and economic benefits, it can also prevent severe consequences like floods through, for example, green roofs. Another highlight is related to an issue

already mentioned in previous questions, the lack of framework and regulation setting the link between spatial planning and circular economy, even more when specifically addressing water.

For the fifth question the answers were broad and covered several areas and entities, from the knowledge institutes (universities mostly) to the municipalities and the industries, the results evidence that all of them have several issues that need to be addressed in order to successfully pursue a circular economy. One of the problems that affects all areas but particularly the industries is the idea that it's easier to lock themselves and do everything internally instead of having to share with people outside of the company. Whether from the amount of bureaucracy or a simple mentality issue, companies tend to close themselves as much as possible, avoiding dealing with other companies unless it's absolutely necessary. From everything stated so far, it's evident that this behavior is the complete opposite of how a circular economy should work and it's an issue that needs to be addressed. Other important issue is related to the role of the municipalities as leaders, in the sense that if there is a specific set of measures that would contribute to a circular economy and the municipality promotes them as beneficial, instead of enforcing them to the population they should lead by example and apply those same measures to every municipal building (as much as possible). That way the general population and other relevant stakeholders are more likely to see the benefits for themselves and follow than if they were just forced to do it. Other situation to address by the municipalities would be the separation of water by type for every building, particularly in urban areas. This could lead to the reutilization of grey water immediately with minimal treatment, thus saving tap water, while also allowing to separately collect black water to be treated and possibly exploited for energy and nutrients. Another issue, and this time related to the universities is related to the quality of the investigation and also the quality of the transition between theory and practice. If the research is poorly done and the subsequent results fall short of what was expected the trust of the population and the stakeholders regarding the institute responsible for that research would be hindered, and trust is not an easy thing to recover. To that same extent, if whoever is responsible to put to practice the research and either fails to thoroughly follow the instructions or uses low quality material, among other faults, it will decrease the trust on both the university and the municipality or company responsible for the application of the measures, so a responsible operation from all entities and a proper supervision are very important. A legislative barrier mentioned is the water tariffs which are hard to balance in order to not make water an expensive asset for the population, considering it's an essential good for all living beings, but also not to make it cheap,

to avoid overuse and waste. A recurring idea, for previous questions but also this one, is that regulation itself did not take into account circular economy solutions when being planned and, as such, is one of the greatest barriers.

The final question delves into the matter of the actors, their relevance and how can they promote the transition to a circular economy. The first highlight goes to a consensus among all interviewees, the fact that the government, either at the national level, or local level through municipalities, is an entity that plays a major role regarding the transition to a circular economy. And the fact that this was the only entity mentioned by all evidences that it is probably the one that has the highest influence of all. The other relevant actors mentioned were the universities, as a source of innovation, the industries, the general population and the water utilities. The measures addressed as ways to reinforce circular economy were the application of lower scale, specialized technologies to each location, instead of large scale, generalized ones, that would allow to address every opportunity independently and take the most from it, the way governments address the legislation issues that hinder innovative measures that could be improved by creating a specialized office dedicated to adapt legislation and assist stakeholders on how to overcome the issues, while at the same time promoting the information and public participation of the general population.

5.3 Conclusions

The direct contact with people related to entities with a major role in the transition to a circular economy allowed to identify some major aspects not yet seen in either the literature review or the national plans analysis and also reinforce some already mentioned in both.

The highlights on the already mentioned factors go to the legislation, innovation, stakeholder relations and economic factors, while the actors remain essentially the same, with general population added while international level government removed. Again the results are similar to the ones obtained in the previous chapters, revealing some consistency even from all the different sources.

6 DISCUSSION OF RESULTS

This section of the dissertation will assess the findings of the study and take an in-depth look at how exactly each of the topics evidenced affects circular economy, specifically related to water and spatial planning, and also ways to overcome the obstacles identified.

Requirements

- **Collaboration between stakeholders –** As stated several times so far, stakeholders' relations can make or break any form of cooperation between entities, either from the same sector (e.g. industry-industry) or across different ones (e.g. industry-municipality). Considering that sharing is a big part of circular economy for both physical and immaterial property and it involves actual interactions between stakeholders, unless there is availability and open mind from everyone the progress is halted or at least severely slowed down. In fact, stakeholders' relations are so important that the E.U. has created a platform called "European Circular Economy Stakeholder Platform" whose goals is to, and I quote, "*provide a meeting place for stakeholders to share their solutions and team up to address specific challenges, while bridging existing initiatives, and advocating the circular economy at national, regional and local level, and supporting its implementation.*"(About the Platform | European Circular Economy Stakeholder Platform n.d.).
- **Adequate mentality from the stakeholders –** This topic is somewhat broad and can be related to many aspects, however for this case I'm specifically addressing the open-mindedness necessary to adapt to new realities. Circular economy relies a lot on innovation and the way it makes previously impossible tasks possible and already possible tasks more efficient. However, in several occasions, innovation leads to out-of-the-box solutions that no matter how effective they may be, if they do not get accepted by the stakeholders they are directed to, they are pointless. This is where the mentality matter comes to light since open-minded stakeholders tend to place less obstacles and therefore progress faster than the close-minded pairs.

Actors

- **International and national level government –** These are the ones responsible for the large-scale measures that can affect all stakeholders at once. Their roles as spearheads for the circular economy consist, above all, on legislation making and adapting, but also as promoters by simply "advertising"

circular economy or even more by providing financial support and technical knowledge to stakeholders struggling to transition to a circular economy.

- **Local and regional level government –** This level of government is responsible for most of spatial planning and usually lower-scale support (small financial incentives and projects). According to Local Governments as a driver for the Circular Economy - KATCH-e (n.d.), an association called "Local Government Denmark", which represents all 98 local governments in Denmark, published a catalogue in which mentioned some recommendations for how should local governments integrate circular economy. The list, covering four areas, is the following:
  - Strategy, planning and supply;
  - Business development;
  - Procurement and tenders;
  - Building and construction.

  These areas cover several opportunities to support a water circular economy, with some examples being the use of efficient materials and techniques for construction, business deals with companies with water saving/recirculating processes, financial and technical support for small stakeholders, among many others.
- **Industries –** Industries play one of the most important roles as they are directly responsible for the consumption of around 90% of the water in Portugal (considering, for the analysis, the agricultural sector as part of the industrial actors). With such a large percentage of the water being used by companies it's only natural that this is the area in which specific measures need to be focused on. However, since the industrial labor can include water in so many and so different processes like processing, cooling, cleaning, diluting, among many others, and even when used for the same purpose, water can have completely different characteristics depending on what kind of industry is using it. There is a great number of measures to be applied concerning water in industrial use, with the general ones being the introduction of more efficient equipment, the recirculation of water or the use in a closed loop, and these measures would all promote a sustainable use of water to a certain degree, however, given what it has been said so far, to go even further It is necessary to assess each kind of industry for its water use to then be able to introduce newer measures, specifically cases of symbiosis in which one industry's waste water could be used as another's source of water. But this cannot be done lightly since small variations in water quality could severely hinder the user's production.

- **Water utilities –** This refers to the entities responsible for supplying clean water and also retrieving waste water from all sectors. It represents a public service and, as such, is partly responsibility of the government, but since it also works as an industry it does not fit directly into the responsibility of either of them, thus being mentioned on its own. Since these institutions handle water from several sources directly, the application of measures at their level would influence all other sectors, whether at the supply or the retrieval phase. They are also in a prime position for the recovery of nutrients and energy from waste water, being able to convert waste water treatment plants into nutrient factories.
- **Knowledge institutes –** Knowledge institutes refer, mostly, to universities and similar facilities for they are the ones responsible for a large portion of research done on any given matter, either autonomously or on demand. They are a large source of innovation and, consequently, an important booster for the circular economy. There are, however, two important notes to mention. First, the research done by these institutes is only useful if shared with other peers and interested entities, highlighting again one of the already mentioned requirements. Second, no matter how good and productive a given institution has been with its research, if at any given point the practical outcome of a measure developed at that same institute fails, its credibility will be shaken and trust and future partnerships may be hindered. And it doesn't even necessarily mean the research was poorly done, the entity responsible for its application may be the one to blame, at which case the research institute will just be dragged by association. This just means that all partnerships must be thoroughly planned and credible institutions at both ends are a must.
- **Population –** Population is responsible not only for direct circular measures like the use of grey water for toilets, which anyone can install at home, but mostly for the pressure it applies on the consumer market. Companies need to follow the market trends in order to get the most profit and currently environmentally friendly solutions get high praise from the citizens and, as such, can be seen as interesting from an economic point-of-view. This leads to companies developing and applying new measures to protect the environment, or in this case, to use water sustainably, that will end up working as marketing, thus generating more income. There is, however, the opposite scenario, meaning there are cases in which perfectly viable solutions are developed and yet they are refused by the general population, thus undermining and invalidating that hypothesis. One good example is the use of treated sewage water for consumption. As stated by Hieminga (2017), it is possible to treat waste water to the point where it is perfectly safe to consume, however most

people react to this scenario with repulsion, known as the “yuck factor”, which is simply the instant rejection of new technology. This is also a mentality issue, as stated in next topic, and is extremely difficult to overcome, needing a slow and progressive approach.

Barriers (and ways to deal with them)

- **Legislation –** Legislation covers all aspects regarding the production and commercialization of any asset and service, thus being an unavoidable aspect when considering the implementation of circular measures. However, confuse (e.g. the transition from one industry’s residues to another’s raw materials is not always a well-defined subject and can discourage industrial symbiosis scenarios), strict (e.g. hard to achieve discharge values leave little room to innovate), complex (e.g. multiple step legislation can discourage stakeholders just for the amount of trouble), or even too soft (e.g. easy to achieve discharge values or lack of supervision lead to accommodation) legislation can lead to a halt in the progress towards a circular economy. There are several ways to deal with legislation related problems and some are listed below:
  - Rigorous supervision of legislation;
  - Gradual scaling of legislation;
  - Creation of cabinets with the purpose of assessing current legislation and assist stakeholders on overcoming legislative barriers.
- **Economic factors –** The adoption of circular measures requires, most of the times, the adaptation of already existing processes, infrastructures or equipment, even more when putting into practice completely innovative concepts, and although one of the focus of circular economy is the balance between the environmental and economic aspects, not all the stakeholders involved are able to make large investments nor prepared to wait for the long term for a financial return. This is true even for major stakeholders like municipalities and industries and can be a very complicated barrier to overcome. However, there are a few solutions, even if only partial, that are listed below:
  - Public contests with financial related prizes (from any level of government, from local to European);
  - Fiscal incentives;
  - Shared costs through partnerships (e.g. several industries could come together and build a communitarian wastewater treatment plant, instead of individual treatment plants).

- **Mentality –** Mentality related barriers are some of the most complicated to overcome and require a careful approach. This kind issue can affect all the stakeholders in one way or the other and is usually characterized as an intrinsic set of values that differ from the way progress is heading. It can appear as a lack of interaction between peers in cases where there would be great advantage in doing so, it can also appear, as mentioned previously, as a reluctance in accepting new technologies already proved safe and effective, among many other examples. There aren't many ways to deal with the problem, but the most basic and common approaches are a gradual process, with small changes every now and then in the intended direction that will progressively accustom all stakeholders to the matter, and a proper (in)formation of everyone, especially focused to the younger generations as they would become less likely to raise issues after growing older.
- **Technology –** Progress is always limited by the reach of current technology, and the transition to a circular economy is no different. Whether by being technologically impossible to execute a given process or by not being economically efficient, technology can be a limiting factor to the adoption of new measures and approaches. The best way to deal with this obstacle is to invest on research in order to find new and innovative ideas.
- **Segregation –** In the past the isolation of industrial and agricultural areas outside of urban zones was necessary to avoid a number of inconveniences like traffic jams and severe pollution, however currently there is no longer the need to make such separation. This doesn't mean we should place a factory at every corner of a city and there are obviously some industries that need to be isolated, but there are many cases which would bring more benefits if included in urban areas than if isolated, allowing to develop industry-municipality symbiosis for example for heating.

Drivers

- **Innovation –** Innovation can be a major factor pushing forward circular economy as it can overcome technological and procedural barriers. However, innovation is a process that comes gradually with research and investment, so it usually takes time and money and is, therefore, hard to force. It also needs to adapt to the ever-changing legislations since a small legislative change can completely override upcoming innovations. In fact, innovation plays such a relevant role that the European Commission developed a program called "Innovation Deals" with the purpose of addressing legislation and regulatory barriers to innovations. As stated by them: "*The objective of an Innovation Deal is an in-depth understanding and clarification of how an EU rule or regulation applies. If a rule*

or regulation is confirmed as an obstacle to innovations that could bring wider societal benefits, the Deal will make it visible and feed into possible further action (About Innovation deals | Research and Innovation - European Commission n.d.)". As a matter of fact, it's also worth mentioning that the first innovation deal was related to water and focused on water reuse. There are many ways to promote and support legislation, with some of them mentioned below:

  - Financial and fiscal incentives;
  - Regulatory and legislative support;
  - Creation of platforms to share knowledge and ideas.

- **Legislation –** The same way it can be a major barrier, legislation can also play the role of a driver when planned properly. By gradually increasing the requirements or setting more demanding release values for effluents, legislation will force stakeholders to adapt and evolver their processes and equipment to other more efficient and environmentally friendly.
- **Spatial planning –** Spatial planning is an instrument that can be used at local, regional, national and international level and plays a major role as a coordinator, developer and regulator in current society, it influences infrastructure building and the use of natural resources. But how exactly can that affect the transition to a circular economy, especially regarding water use? Spatial planning has the ability to link all areas of activity, urban, rural and agricultural, in a common, integrated strategy. This allows previously unrelated or barely connected activities to thrive together with symbiosis extending across all sectors. It also allows to take preemptive action by preparing future interactions even before their actual implementation, like the example of Forssa, in Finland. This way the ideal conditions for symbiosis will be created, allowing the stakeholders to save time and money on long distance transports while also reducing atmospheric pollution from vehicles, since most of the inputs needed are located in the area. This is particularly relevant for the case of water since the exchange from one local to the other can be done through pipes, not requiring vehicles. However, it is currently highly frequent to find all these locations segregated, with industries to one side, urban areas to the other and agricultural to yet another, leading to difficult interactions between them. This is one of the most important changes that need to happen regarding spatial planning to better accommodate circular economy solutions, with other ways it can contribute being mentioned below:
  - Integrating all sectors as one in the planning process;
  - Promoting environmentally sound construction practices and transportation;

- Protecting natural resources by integrating forests and water courses in urban planning;
- Protecting urban areas through, for example, green spaces.

The table 16 presents a summary of the findings of this study, with a small description of the reason why they are important.

Table 16 - Factors identified as relevant for the transition to a circular economy in Portugal.

Topics	**Factors identified**	**Description**
Requirements	• Collaboration between stakeholders; • Adequate mentality from the stakeholders;	• Sharing can only happen with agreements between stakeholders; • No matter how good a measure is, if not accepted by the targeted audience it has no use;
Actors	• Local, regional, national and international governments; • Industries; • Water utilities; • Knowledge institutes; • Population;	• High level governments are the law makers, the ones that can single-handedly drive change while regional and local are responsible for most spatial planning; • Industries, as producers and consumers, are the most interested in changes (especially if economically advantageous); • Water utilities are the main responsible for the direct management of water; • Knowledge institutes objective is to find new information/improve the existing, thus moving towards innovation; • Population represents the consumer group and directly affects all actors;
Barriers	• Legislation; • Economic factors; • Mentality; • Technology; • Segregation;	• Legislation can halt progress whether by being too soft or too strict; • A circular economy transition requires investment in research, new equipment and infrastructures, which is not always easily accessible; • Whether due to distrust or simply because it's easier, several industries tend to close themselves to outdoor contact as much as possible, which can difficult sharing; • Several processes cannot be applied because there is no technological equipment able to do it, or not efficiently enough; • Segregation limits the existence of symbiosis and other beneficial relations across all sectors;
Drivers	• Innovation; • Legislation; • Spatial planning.	• Innovation leads to progress, to the development of more efficient and better practices; • Legislation can promote a sustainable development by setting progressive yet fair requirements; • Spatial planning has a major role to play by supplying the means to and connecting all sectors as one.

It's also important to address some of the findings that caused surprise in a negative way. For instance, Denmark has been considered for some time now as a frontrunner in circular economy matters, and the results obtained through the analysis of the national documents reveals just the opposite of that. There are some possible explanations such as a limitation in the methodology used or the possible existence of other national documents addressing circular economy matters, particularly regarding water and spatial planning.

7 Conclusions and recommendations

The purpose of this study was to analyze how water and spatial planning were addressed regarding the transition to a circular economy, particularly in the Portuguese context. Furthermore, the main factors either hindering or fostering water circular economy were also assessed in order to better understand how to make the transition faster and smoother, with some recommendations on how to overcome obstacles being identified.

The first remark to be highlighted is the main objective of the study, the relation between water and spatial planning in the context of circular economy. The results are clear, although there is a direct relation and spatial planning can promote water circular economy efficiently and in a multitude of ways, with one of the major evidences being its role as a promotor for symbiosis, neither the literature review nor the national plans for the transition to a circular economy directly mention the connection between the two topics. Water is addressed somewhat frequently, spatial planning barely mentioned in most cases, however there are no direct mentions to both together. Although it's true that the argument could be made that by mentioning resources water should already be included, in most cases that's not the case and the resources refer only to materials. After literature review this result for the national plans was already expected considering the low number of articles addressing water in the context of circular economy comparing to the global number of articles on circular economy, and even more considering the almost neglectable amount that addresses spatial planning.

Addressing specifically the literature review, the scientific documents analyzed provided the first piece of intel regarding the actors with the most relevant role in the context of a circular economy, which combined with the findings on the analysis of the national plans established the basis for the contact phase, and also allowed to identify some of the barriers and challenges concerning the same subject. Further down the conclusion is an extensive approach to the findings and also a table summarizing them.

The analysis of the national plans followed the tendency observed for the literature review, with a relatively small number of references to water but even smaller for spatial planning. The contents addressed a large number of water related topics, with the major findings on both actors, barriers and drivers being nearly identical to the ones mentioned by the interviewees.

The enquiries gave a direct insight on the state of the transition to a circular economy in Portugal by directly contacting with persons of interest in the matter of circular economy and also water management and spatial planning in the Portuguese context. The first thing to highlight is the similarity between all the actors, barriers and drivers mentioned by the people interviewed and the ones identified through the analysis of both literature review and the national plans, evidencing that, overall, the relevant parties and challenges affecting the transition to a circular economy in Portugal and the ones being faced by other countries are very similar. This doesn't necessarily mean that all the countries have the same problems to address since they are all in different stages of transition, but probably means that at any point of that transition the problems being faced are very likely to be the same as others at that same point.

Addressing now the most relevant findings for the Portuguese context, and starting with the requirements, the factors identified as relevant were two, collaboration between stakeholders and adequate mentality from stakeholders. The first is related particularly with cases of symbiosis which require connections between different entities and cannot happen unless both parties are willing to do so. Second is the mentality of the stakeholders which need to be on pair with the targeted audience for optimal results, otherwise risking developing an idea, no matter how good it is, that will never be able to be put to practice. The second topic of relevance are the actors, which are the individuals and institutions which, in one way or the other, can change the course of the transition to a circular economy. The national and international governments dictate the laws that rule everything, being an unavoidable entity for any activity, but are also responsible for the support either financial or technical, although it wasn't possible to ascertain how exactly is the Portuguese government doing this or how it plans to do it in the future. Then there are the municipalities which are responsible for lower scale support compared to the national and international governments, but on the other hand have a much more important role managing spatial planning, which is a large contributor for the transition to a water circular economy. There are also the industries which are directly and indirectly responsible for innovation by either investigating by themselves, something not easy to achieve by all, or by requesting universities assistance. They are also the ones more interested in any progress that allows them to increase profit, which is also one of the goals of a circular economy, the economic advantage associated with environmental benefits. The knowledge institutes also play a prominent role by leading the way for the development of new concepts and technologies. Lastly there is the population, who plays an

important role particularly for urban measures associated with spatial planning. The third topic is also the one with highest relevance for the study since it is related to the ways in which the transition to a circular economy can be hindered or even halted. Starting with legislation, there are many ways it can negatively affect the transition and the most common are for being confuse, too strict or too soft (needing a middle ground in order to not affect progress), or even for being too complex. This is the government's responsibility and the ways to deal with it too. Then there are the economic factors, which being realistic are always a problem no matter the topic. In this case, the transition to a circular economy, it requires the adoption of new processes, new equipment and even new infrastructures, none of which are usually free. This means that in order to evolve, stakeholders need to make a financial investment in those areas while, most of the times, not expecting a financial return on a short term. Then comes the mentality which while being a requirement, can also be defined as a barrier in some cases, with the best example being the "yuck factor" mentioned in the discussion of results, which is the instant rejection of a new technology that steps outside of the ordinary, with the treatment of wastewater to drinking water as a prime example. Another barrier identified is the technology which limits the actions of all stakeholders according to what exists at the time. This not only limits processes that are straight off impossible to achieve with current technology, also limits others that are possible but not efficient enough resulting in either high costs or low results. The last barrier identified is segregation of all sectors which means that interactions between industries, municipalities and agricultural fields are a lot harder than the ideal. Obviously, this segregation has a reason to be, or at least had in the past, however nowadays the line defining all sectors is a lot more blurred and in many cases there would be more benefits to think of them as a whole than to isolate them. Finally, the drivers. These are the factors responsible for the development of the transition to a circular economy at many levels and represent areas that should be focused in order to accelerate the transition. The first factor identified is legislation, which while can be an obstacle, it can also promote circular economy by, for example, setting progressive yet fair requirements which will lead industries and other entities to evolve without the need to make large investments at a single time, and taking them in the right direction. Then there is innovation which is responsible for overcoming some barriers, particularly the ones related to technologic and processual aspects. Lastly there is spatial planning, one of the focus of the study, which is a large driver for the transition to a circular economy through its ability to promote symbiosis, not only industrial but with other institutions as well, which by itself already points out another major barrier heavily influenced by spatial planning which is the segregation of all sectors.

Answering the final question defined in the introduction, based on the results obtained, Portugal is giving the same focus to water and spatial planning as Finland and Scotland, but less than Netherlands. This doesn't necessarily mean they are in the same stage of development or are focusing on the same subjects, only that the documents have similar approaches on those subjects.

The research undertaken in the elaboration of this dissertation had its own set of limitations that may have some influence in the results obtained. Starting with the literature review, the low number of articles related to spatial planning and the inexistence of scientific studies relating water circular economy and spatial planning made the start of the study a lot slower than what could have been if the topic was already more comprehensively approached and also made the connection between the two subjects considerably harder. For the national plans, the sample of documents was relatively small and the terms used while searching for both water and spatial planning references could have left out other potential references to those subjects whose words were not included in the search. Furthermore, the topics in which the references were placed are somewhat subjective and left at the author's decision, what can lead to different results for different people making the same analysis. As for the interviews, the spectrum of experts that accepted to be interviewed was also limited, which narrowed the perspective on the matter.

Further research is required to identify the reasons behind these results as well as to explain why the integration of water and spatial planning is still poorly considered in the formulation of the analysed national circular economy strategies. For future studies on the matter it would be recommended to guarantee an interview with experts (preferably more than one) currently related to each one of the actors identified as it would give a direct insight on the state of the subject as it is presently, particularly for government related individuals since it was identified as the most relevant actor and is directly responsible for legislation, the factor that more influences water circular economy for the better or for the worst, according to the findings.

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Appendixes

Appendix 1 - Total water references for the Portuguese document on circular economy**.**

Chapter	Quote (and page)	Description (water)
Foreword	-	-
Executive Summary	-	-
Introduction (Why: the need for transition to a circular economy; What: characteristics, strategies, advantages; How: international tendencies)	"Paradigmatic case is the water efficiency in which only 65% of the captured water is effectively used, and where reutilization is, still, residual compared to other member states." (Page 13)	Reference to the water use efficiency as being lower than what is should be.
	"Significative reduction of greenhouse gas emissions, through waste management improvement and reduction of total needs for primary resources (water, energy, land and materials), generating positive impacts for the natural system." (page 18)	Mentioned as one of the resources with its consumption reduced due to reutilization of products.
	"Green deals|acordos circulares - (energy ,mobility, climate, biodiversity, bio economy, resources, water, construction, agri-food); (page 20)	Reference to the Dutch circular economy programme that mentions water as an area of focus.
	"Sectors: … -Water (Page 20)	Reference to the Luxembourg's plan that has water mentioned in the sectors topic.
Plan (Ambition: how will a circular Portugal be?; Approach: methodology and planning; Governance model: manage, advance and finance)	The first innovation deal approved, in the water sector, supports circular economy. We want the European legislation is easier to implement and use. The innovation Deal helps us in that regard" "Sustainable use of waste water treatment using the technology of anaerobic membranes bio-reactors: This innovation deal approaches legislative barriers to the use of waste waters. This technology eases the extraction of energy and nutrients and accelerates the reutilization of treated water for irrigation, contributing to overcome the challenges of water scarcity. The deal explores the paradigm change: from waste water treatment plant to hydric resources installation." (Page. 30)	Reference as an exemple of na innovative measure for the treatment of waste water, mentioning legislative barriers.
Act (Actions structure; Macro actions; Sectorial agenda; Regional agenda; Calendar)	"Reduces the pressure on soil occupation, avoids the excessive use of water and fertilizers (precision agriculture), reducing energetic intensity (lesser need to refrigerate/transport), allowing industrial symbiosis (e.g. fish production in aquacultures), reducing the need for packages, stimulating production and local consumption… uses 90% less water that the traditional way and doesn't need of pesticides nor herbicides." (Page 41)	Reeference to an innovative method introduced to agriculture that allows to save water.

Appendix 1 - Continuation

Chapter	Quote (and page)	Description (water)
Act (Actions structure; Macro actions; Sectorial agenda; Regional agenda; Calendar)	Whole page. (Page 44)	Reference to a planned action with the goal to increase hydric efficiency and decrease waste.
	Action - "Built environment: more efficiency and material productivity" "Objectives: … Reduce the water consumption" (Page 48)	Reference to the objective of reducing water consumption .
	"The Valley is the physical location where the ambition to develop the Netherlands into a hotspot in a Circular economy is developed and demonstrated. Materials, water and energy are kept in a continual cycle." (Page 53)	Reference to a case in the Netherlands in which water is kept in a closed loop cycle.
References	-	-
Team	-	-
Appreciations	-	-

Appendix 2 - Total spatial planning references for the Portuguese document on circular economy.

Chapter	Quote (and page)	Description (S.P.)
Foreword	-	-
Executive summary	-	-
Introduction (Why: the need for transition to a circular economy; What: characteristics, strategies, advantages; How: international tendencies)	-	-
Plan (Ambition: how will a circular Portugal be?; Approach: methodology and planning; Governance model: manage, advance and finance)	"For the micro level case, the focus are the regions and territories and the strategies of acceleration for a circular economy that better fit the socio-economic profile. Like the sectors case, it's important to establish specific agendas and, currently, some regions already moved on with their own plans, in articulation with Operational Programs of Portugal 2020. Is at this level that the circular economy converges with the valorization of territory, reason why it were selected strategies in which regions are working on (e.g. industrial symbiosis)… " (Page 26)	Reference to the scale of actions which can be macro, meso or micro, with spatial planning being included in the latter.
Act (Actions structure; Macro actions; Sectorial agenda; Regional agenda; Calendar)	Key sectors. (Page 45)	Reference to a planned action with spatial planning being a relevant part of it.
	"The BLC3 wants to accelerate the development of industrial symbiosis between different industries of the region, in which managers interact and share resources to minimize the need for raw-materials and waste production. " (Page 46)	Reference to resource sharing and interactions between companies in industrial symbiosis.

Appendix 2 – Continuation.

Chapter	Quote (and page)	Description (S.P.)
Act (Actions structure; Macro actions; Sectorial agenda; Regional agenda; Calendar)	Action - "Built environment: more efficiency and material productivity" (Page 48)	Reference to spatial planning as an important tool to achieve the circularity goals.
References	-	-
Team	-	-
Appreciations	-	-

Appendix 3 - Total water references for the Scottish document on circular economy.

Chapter	Quote (and page)	Description (water)
Excutive summary	-	-
Introduction	"In our existing economy, we “take, make and dispose”. We take resources from the ground, air and water; we make them into products and structures; then we dispose of them." (page 6)	Mentioning of water as one of the exploited resources in our current society.
	"There are significant environmental benefits to a more circular economy: from reducing greenhouse gas emissions, relieving pressure on water resources, virgin materials and habitats, and limiting pollution of air, soils and watercourses." (Page 7)	Reference of water as one of the resources that would benefit from a circular economy transition.
Making the transition	-	-
Waste prevention	"In 2013 we introduced a target to reduce Scotland‟s waste by 7% by 2017 from 2011 levels, 15% by 2025. In the same year, we established Resource Efficient Scotland, delivered by Zero Waste Scotland, bringing together expertise and advice on energy, materials and water. This service helps businesses and organisations access support to use resources more efficiently." (Page 11)	Reference of water as one of the areas of relevance to increase the resource efficiency.
Design	-	-
Reuse	-	-
Repair	-	-
Remanufacture	"Reduced requirements for material, water and energy mean remanufactured products can cost less than the equivalent new products, and hence significantly boost productivity, competitiveness and profitability. Remanufacture provides an excellent circular economy business model, especially where products are leased to the customer or have an incentivised return mechanism." (page 22)	Reference to the possibility of reducing product costs by reducing the requirements for water.
Recycling	-	-
Producer responsibility for reuse and recycling	-	-

Appendix 3 – Continuation.

Chapter	Quote (and page)	Description (water)
Recovering value from biological resources	"Linked to the use of fertilizers and growing media, we have committed to supporting the phasing out of peat for horticultural use. Peatlands are important for biodiversity, water quality and reducing carbon emissions – and need to be well managed and protected. The National Peatland Plan21 sets out Scotland‟s ambitions for protecting, managing and restoring our peatlands." (Page 31)	Reference of water as one of the areas affected by the Peatlands.
Energy recovery	-	-
Landfill	-	-
Communications and engagement	-	-
Skills for a circular economy	-	-

Appendix 4 - Total spatial planning references for the Scottish document on circular economy.

Chapter	Quote (and page)	Description (S.P.)
Excutive summary	-	-
Introduction	-	-
Making the transition	-	-
Waste prevention	-	-
Design	-	-
Reuse	-	-
Repair	-	-
Remanufacture	-	-
Recycling	-	-
Producer responsibility for reuse and recycling	-	-
Recovering value from biological resources	-	-
Energy recovery	Where thermal treatment plants are required, we wish to see only high quality combined heat and power schemes developed. As with other thermal electricity generation plants these should be located where there is a demand for heat to make the most of our resources, while minimising environmental impacts including meeting Scotland‟s high standards on air quality. This is supported by a regulatory framework through planning, Pollution Prevention and Control regulations on the use of waste heat and by programmes such as district heating support for local authorities. (Page 33)	Spatial planning as a way to prvent environmental impacts.
	SEPA produces annual figures of waste infrastructure capacity needs for a variety of technologies including thermal treatment infrastructure. This provides a guide to the waste management industry, investors and local planning authorities as to the likely level of required infrastructure. (Page 34)	The role of spatial planning for the management of waste.

Appendix 4 – Continuation.

Chapter	Quote (and page)	Description (S.P.)
Energy recovery	We will work, with SEPA and Zero Waste Scotland, to continue to improve the way that we provide and present information on the anticipated capacity requirements for future waste infrastructure, for use by planning authorities and industry - helping ensure the capacity of waste infrastructure developed, such as thermal treatment facilities, is appropriate. (Page 34)	The role of spatial planning for the management of waste.
Landfill	-	-
Communications and engagement	-	-
Skills for a circular economy	-	-

Appendix 5 - Total water references for the Dutch document on circular economy.

Chapter	Quote (and page)	Description (water)
Promising prospects (Changes in a broad sense; Unifying theme in policy; International context; Structure)	-	-
Raw material use: the great challenge of the 21st century (Necessity; Economic opportunities)	Natural capital is the world's stock of natural ecosystems that produce a stream of valuable products and services, now and in the future. It is an extension of the economic notion of capital (manufactured means of production) to include the products and services that the natural environment produces. For example, a forest or a fish population may produce an indefinitely sustainable flow of new trees or fish. Natural capital can also provide services, such as breaking down pollutants, water catchment, and erosion control. The flow of services from ecosystems requires such a system to function properly at full force. (source: Wikipedia) (page 9)	Reference to one of the services provided by natural capital, namely water catchment.
	"By preventing pollution with circular products and services, we will save money spent on water purification and, over time, save on the costs of clean-up and health. The fact that this can yield not only an environmental benefit, but also an economic benefit is demonstrated by the Dutch invention of dying textiles with CO2. This invention is now increasingly being used by textile and shoe producers worldwide. This method replaces water – traditionally used in the dying process – by CO2. This reduces raw material requirements, cuts back the use of water, energy, and chemicals, and eliminates the cost of purifying wastewater to be released." (Page 12)	Reference to the economical benefits of a circular approach concerning raw materials. Gives as an example the case of the textile industry in which an innovation allowed the use of CO2 instead of water, therefore decreasing the need for it.

Appendix 5 – Continuation.

Chapter	Quote (and page)	Description (water)
Changing course (Vision; Strategic goals; General Policy (for change): removing obstacles; Cooperation; Specific Polic (for change): approach for each sector or value chain; Direction and monitoring)	"There is an extreme imbalance between the short life span of textiles and the permanent impact these materials have. We use mainly textiles that are no longer suitable for wear (70%) and process them in a smart process – without the use of water or additional chemicals, which yields yarn and textiles with a considerably better ecological footprint!" (page 18)	Reference to a water saving process used in a textile processing industry.
Interventions (Fostering legislation and regulations; Intelligent market incentives; Financing; Knowledge and Innovation; International Cooperation)	“By gradually scaling up the standards to establish, say, full circularity with respect to emissions to land, air and water, companies will be forced to innovate and adopt circular substances and technologies.” (Page 23)	Reference to an enforcement of innovation by scaling up the standards.
	"In recent years, Statistics Netherlands (CBS) has compiled time series, via the national Material Flows Monitor (Monitor Materiaalstromen), of material use in the Netherlands linked to the Environmental Accounting, including water consumption, ownership ratios, and international value chains. Based on this work, the supply security risk for 64 metals and minerals for the Dutch economy could be brought to light. The circular potential of 1,100 abiotic product groups can now also be determined in terms of quantity. The monitor is being continued on the same basis, i.e., with the environmental accounting linked to the material flows monitor." (Page 32)	Reference to water as one of the material flows with its data gathered by the Satistics Netherlands (CBS).
	"Furthermore, in 2016 the NWO programme Closed Loop Cycles – Transition to a circular economy (Gesloten Kringlopen – Transitie naar een circulaire economie) will be launched. This cross-sectoral programme (5 million euros) targets the Top Sectors of Agri and Food, Logistics, Horticulture & Cultivation Materials, and Water." (Page 34)	Reference to water as one of the top sectors targeted in the NWO programme for the transition to a circular economy.
	"The EU is an important source of funding for research and innovation for the circular economy (Horizon2020 and LIFE). For the budget years 2016 and 2017, Horizon2020 has allocated approximately 650 million euros to circular economy projects, including funds for large demonstration projects aimed at closing the loop in the raw materials and water cycles, funds for regional development projects, and funds for the development of new business models." (Page 36)	Reference to water as one of the sectors receiving large amounts of funding for projects attempting to close the loop.
	"I decided to join forces with Black Bear, a company that recycles carbon black from car tyres. This resolves two issues. First of all, we reduce the pile of discarded car tyres: some 2 billion a year. In many cases, these are burnt, emitting high levels of CO2, or they end up on a landfill. In Africa, they are a source of malaria problems, because mosquitos thrive in the water that collects in the tyres." (Page 37)	Reference to water as a mean of propagation of diseases, not relating in any way water with circular economy.

Appendix 5 – Continuation.

Chapter	Quote (and page)	Description (water)
Interventions (Fostering legislation and regulations; Intelligent market incentives; Financing; Knowledge and Innovation; International Cooperation)	"In recent years, the Netherlands has established an international reputation as a frontrunner in the circular economy, with knowledge and experience in the areas of waste and nutrient management, technological and social innovation, an integrated approach and crosssectoral cooperation with companies, knowledge institutes, and governments. Dutch companies are international leaders in the fields of water, agriculture, maritime activities, logistics, and governance, and presenting integral solutions." (Page 38)	Reference to water as one of the fields in which the Dutch are frontrunners, with knowledge and experience second to none.
	"The Ministry of Infrastructure and the Environment, together with the trade association Envaqua for water and environmental technology, will soon launch the platform Holland Circular Hotspot. This platform focuses on companies and knowledge institutes in the waste and recycling sectors that (want to) operate internationally, and on companies and knowledge institutes that focus on the transition to a circular economy and that (want to) share their knowledge and expertise internationally." (Page 41)	Reference to a trade association that deals with water and environmental technology.
	"The Cabinet is committed to cooperating with countries that export raw materials and with countries that have large waste flows around rapidly developing cities on the basis of the so-called “mutual gains approach”, which aims to remove the negative social and environmental impact of our linear economic system and to convert it into opportunities for sustainable economic growth. An example of such an approach is the relationship that the Netherlands has entered into with Morocco. This relationship was established in light of Morocco’s strong position as an exporter of phosphate and its vulnerability with respect to water management (a scarcity of water) due to climate change." (Page 42)	Reference to international partnerships that focus on being beneficial for both the economy and the environment, with the example of Morocco and its water vulnerability.
Priorities (Biomass and food; Plastics; The manufacturing industry; Construction sector; Consumer goods)	"In a response to the WRR [Dutch Scientific Council for Government Policy] report Towards a food policy, the Cabinet presented its views on food policy to the House of Representatives on October 30th, 2015. In its response, the Cabinet indicates to pursue an ecologically sustainable food system in which raw materials, energy, water, and nutrients are utilised economically and efficiently, the preservation of natural capital is taken into account, and natural capital is used in a sustainable manner. This means that the quality of soil, water and air is protected, and biodiversity is maintained, while at the same time reducing greenhouse gas emissions." (Page 43)	Reference to water as one of the areas that will be focused in the food system in an attempt to achieve an ecologically sustainable future.
	“The Cabinet endeavours to support initiatives aimed at closing biomass loops, producing recycled raw materials, and the maximum and multiple valorisation of biomass. Examples include the “Grondstoffenfabriek” [Raw materials plant] Green Deal initiated by the water authorities to extract valuable raw materials from waste water, and the “Business with biomass and biobased gas” Green Deal.” (Page 46)	Reference to the extraction of valuable nutrients from waste waters to then use in other activities.

Appendix 5 – Continuation.

Chapter	Quote (and page)	Description (water)
Priorities (Biomass and food; Plastics; The manufacturing industry; Construction sector; Consumer goods)	"The preservation of a fertile and healthy soil is vitally important to be able to produce biomass for food and other purposes. Soil quality is pressured by the intensive agriculture of the Netherlands. To maintain the long-term health and productivity of the soil, it is important that the soil contains sufficient stable organic matter and optimum volumes of nutrients. Expanding stable organic matter in the soil increases ecosystem services by expanding the water storage capacity, increasing resistance to diseases and infestations, and retaining carbon in the soil in order to combat climate change." (Page 46)	Reference to the increase of water storage capacity by expanding stable organic matter.
	"Efforts are made to optimize the recovery of nutrients from residues in order for them to be reused. However, large sections of the Netherlands fail to achieve the target values set for ground and surface water quality. The Dutch manure policy encourages farmers to minimise the input of nitrogen and phosphate in the cultivation of their crops. This promotes the efficient use of nutrients in agriculture." (Page 46)	Reference to an incentive by the Dutch government that encourages farmers to reduce nutrient use in agriculture in order to not polute the water and the soil.
	"The Ministry of Economic Affairs recently commissioned the Netherlands Environmental Assessment Agency (PBL) to explore what is required to make the food value chain more circular. PBL has indicated that interconnectivity between policy areas must be improved. In addition, PBL has identified preconditions for a circular food system: sustainable use of resources (soil, water, minerals) in the Netherlands and beyond, and optimum use of food and residues." (Page 46)	Reference to water as an important resource that needs to be properly managed for a sustainable use and for a circular food system.
	"There is a huge potential for the recovery of nutrients such as phosphate from residues such as manure, waste water and purification sludge, and from industrial processes, thus contributing to the development of a circular economy." (Page 48)	Reference to the recovery of nutrients from waste water.
	"The proposal presented by the European Commission to review the Fertilisers Regulation expands the harmonisation of the trade requirements for artificial fertilisers to organic fertilisers, soil improvers, and growth media. This can create more room for the production of artificial fertilisers from secondary (recycled) fertilisers, such as base materials from waste (water), compost, digestate, animal manure, and other animal by-products." (Page 49)	Reference to the recovery of nutrients from waste water to be used in fertilisers.
	"This summer – with significant financial support from the national government – we placed a purification unit in the North Sea, 23 kilometres off the Scheveningen coast. A 100 m long prototype, enabling the large-scale removal of plastics from our seas and oceans. This is the first test of this kind in open waters." (Page 50)	Reference to the removal of pollutants, namely plastic, from the seas.

Appendix 5 – Continuation.

Chapter	Quote (and page)	Description (water)
Priorities (Biomass and food; Plastics; The manufacturing industry; Construction sector; Consumer goods)	"A major challenge with respect to plastics is reducing the dependency on fossil resources. In addition, large volumes of plastic end up as litter, which does not belong on the streets or in the oceans. One property of plastic is that it takes a long time to degrade, or it hardly degrades at all. In water, plastic gradually degrades into increasingly smaller (micro and nano) particles. These particles – that can attract toxins – eventually affect the ecosystem and end up in our food system (through, for example, birds and fish)." (Page 51)	Reference to water as a mean in which plastic degradates into smaller particles that in turn affect the ecosystem.
	"Bioplastics constitute a growing international market, in which Dutch companies rank among the leaders with respect to production and processing. Several innovation programmes have provided support, for example, the Biobased Performance Materials programme. Upscaling is also fostered by Green Deals, such as the Green Deal on the Raw Materials of the Water Boards that is working on bioplastics (PHA) from sewage sludge." (Page 51)	Reference to a project that focus on plastics from sewage sludge.
	"One of the conclusions drawn during the European Raw Materials Conference held in April 2016 was that this initiative must be underpinned by an integrated knowledge infrastructure regarding raw materials supply security and circular economy. Furthermore, Europe could mine one of the last scarce earth metal supplies in European soil, the Norra Karr deposit in Sweden, in a highly sustainable manner. The Water and Mining Platform gathers Dutch expertise in order to facilitate such sustainable mining." (Page 57)	Reference to an entity who works with water and mining activities.
	"Resource intensity in the construction sector is high. The construction industry is estimated to account for 50% of the raw materials used, 40% of total energy consumption, and 30% of total water consumption in the Netherlands." (Page 58)	Reference to the water consumption by the construction sector as one of the highest in the country.
	"By 2050, the construction industry will be organised in such a way, with respect to the design, development, operation, management, and disassembly of buildings, as to ensure the sustainable construction, use, reuse, maintenance, and dismantling of these objects. Sustainable materials will be used in the construction process, and designs will be geared to the dynamic wishes of the users. The aim is for the built-up environment to be energy-neutral by 2050, in keeping with the European agreements. Buildings will utilise eco system services wherever possible (natural capital, such as the water storage capacity of the sub-soil)." (Page 59)	Natural capital involving water being used in construction industry as a way to develop more energy efficient buildings.
	"Ten years ago, we changed course. Since then, we have implemented all our projects on a Cradle-to-Cradle basis. A prime example is Park 20|20, a Cradle-to-Cradle Business Park, developed by Delta, and its partners VolkerWessels and the Reggeborgh Groep, which is focused on both people and the environment. To achieve this, we have taken an integral approach to all the flows (energy, water, biodiversity, et cetera), and used sustainable C2C materials." (Page 60)	Reference to water as one of the flows taken into account in a cradle-to-cradle approach.

Appendix 5 – Continuation.

Chapter	Quote (and page)	Description (water)
Priorities (Biomass and food; Plastics; The manufacturing industry; Construction sector; Consumer goods)	"A distinction is made between the design, construction, and renovation phases on the one hand, and the management and maintenance phases of structures on the other. For each of these phases, tools will be developed enabling the RWS networks (the main roads network, the main waterways network, and the main water system) and the ProRail rail network to make more efficient use of resources. Along with these efforts, the networks will achieve energy neutrality by 2030. For example, RWS will circularise its operations by no later than 2030, while ProRail pursues 100% circularity in its S&CE designs by 2030." (Page 62)	Reference to the circularity of institutions linked to civil construction and water infrastructures management.
	"Large-scale paving is undesirable from a climate adaptation perspective. By utilising naturally available benefits, such as the water storage capacity of the subsoil or the cooling effect of greenery, material requirements may be reduced. Natural capital constitutes a tool that helps bring the circular economy closer. Under the Urban Green and Blue Values City Deal, cities are experimenting widely with the use of natural capital (for example, water storage)." (Page 63)	Reference to the natural properties of the soils and their water storage capacity, making use of naturally ocurring conditions to save resources.
	"Prevention and removal of litter in water: With respect to the prevention and removal of litter in the oceans, the Programme of Measures for implementation of the Marine Strategy Framework Directive (KRM) will be continued in 2017. Continued support will be provided to the associated Green Deals, such as those pertaining to Clean Beaches, Fishery for a Clean Ocean, and the Shipping Waste Value Chain. Clean-up campaigns such as those initiated by Stichting De Noordzee and Schone Maas fit in with this integrated approach. As an extension of these efforts, the Netherlands is taking and will continue to take a proactive stance in the implementation of the OSPAR Regional Action Plan, involving joint regional measures for combating marine litter in the North Sea region." (Page 66)	Reference to the removal of pollutants from the seas and beaches.

Appendix 6 - Total spatial planning references for the Dutch document on circular economy.

Chapter	Quote (and page)	Description (S.P.)
Promising prospects (Changes in a broad sense; Unifying theme in policy; International context; Structure)	Make cities and human settlements inclusive, safe, resilient, and sustainable (e.g., through inclusive and sustainable urban development and building capacity for participative, integrated and sustainable planning); (Page 7)	Reference to the importance of urban planning for a sustainable future.
	Protect biodiversity and ecosystems (e.g. by integrating ecosystem and biodiversity values into national and local planning and into development processes). (Page 7)	Reference to the importance of urban planning for the protection of biodiversity and ecosystems.
Raw material use: the great challenge of the 21st century (Necessity; Economic opportunities)	-	-

Appendix 6 – Continuation.

Chapter	Quote (and page)	Description (S.P.)
Changing course (Vision; Strategic goals; General Policy (for change): removing obstacles; Cooperation; Specific Polic (for change): approach for each sector or value chain; Direction and monitoring)	"The Netherlands Environmental Assessment Agency (PBL) indicates that spatial planning solutions can also contribute to the transition to a circular economy. This also comprises the connection with the natural capital policy field. Through business park management and urban planning, companies in industrial parks can make use of one another's materials and residual streams, as shown in Park20|20 in Haarlemmermeer. At the local level, loops are then closed. Regional spatial planning policy offers greater scope for supporting circular activities. The Cabinet aims to develop projects with pioneering cities for the adaptation of local area planning, such as disconnecting rainwater collection in new construction and installing green roofs." (Page 18)	Reference to the need for planning and management for successful industrial simbyosis.
	"The national government and regional authorities in the north and south wings of the Randstad and Brainport Eindhoven signed a declaration of intent on 9 June 2016 to establish a spatial economic development strategy (ruimtelijk-economische ontwikkelingstrategie, REOS). This collective strategy is intended to help these regions to remain internationally competitive." (Page 21)	Reference to the intent of fostering the development of circular economy hubs trhough the collaboration of national and regional governments.
	"The Cabinet will support a circular economy through spatial economic policy that fits in with current initiatives. To optimally deploy the strength of partnerships at various scale levels within the Netherlands in the transition to the circular economy, an integrated toolbox has been developed that will actively be offered to stakeholders at the regional level." (Page 21)	Reference to the support of the government through policies and measures that help regional level stakehoders.
Interventions (Fostering legislation and regulations; Intelligent market incentives; Financing; Knowledge and Innovation; International Cooperation)	"The Smart Regulation programme (Ruimte in Regels) runs up to 2020. In this programme, the government cooperates with entrepreneurs to look for greater room within current legislation to promote sustainable innovations. The programme was initiated following indications from entrepreneurs who felt restricted by legislation when planning innovative investments. The Smart Regulation programme delves into the nature and background of these barriers, brings the relevant parties together and helps them to search for solutions." (Page 24)	Reference to an adaptation of legislation by the governments to make it easier to overcome the barriers, by the stakeholders, to the implementation of a circular economy.

Appendix 6 – Continuation.

Chapter	Quote (and page)	Description (S.P.)
Interventions (Fostering legislation and regulations; Intelligent market incentives; Financing; Knowledge and Innovation; International Cooperation)	"In follow-up to the European Council conclusions and the recommendations of the Social and Economic Council of the Netherlands (SER), the Cabinet will create more room for experimentation within the framework of the Smart Regulation programme (Ruimte in Regels) in order to support circular initiatives in their development. It will do this both in a physical sense (e.g., in spatial planning or in testing facilities) and in the application of regulations (such as the Crisis and Recovery Act [Crisis- en Herstelwet])." (Page 25)	Reference to one of the areas which will have a larger experimentation concerning the "Smart Regulation" programme in order to support circular iniciatives.
Priorities (Biomass and food; Plastics; The manufacturing industry; Construction sector; Consumer goods)	"With respect to biofuels, the Indirect Land Use Change (ILUC) Directive allows member states, among other things, the freedom to set their own limits for the incorporation of conventional biofuels, with a maximum of 7%. The directive also comprises an indicative sub-target of 0.5% for the most advanced biofuels. The implementation of the ILUC Directive marks is an effective step towards enhancing the sustainability of biofuels and the promotion of advanced biofuels." (Page 48)	Reference to a land use directive that affects the sustainability of biofuels.
	The Biobased Building Green Deal was concluded in December 2015; as a follow-up, a ready-to-market biobased house was exhibited at the Innovation Expo of 14 April 2016. The demand side is also beginning to move now, for example, in the province of Noord Brabant and the city of Amsterdam.They are planning to focus on the use of biobased construction materials in new buildings and renovations, in keeping with the circular economy. (Page 61)	Reference to the planning of cities focusing on biobased materials for constructions and renovations, thus minimizing the amount of waste from that sector.

Appendix 7 - Total water references for the Danish document on circular economy.

Chapter	Quote (and page)	Description (water)
From a linear to a circular economy (Transforming our society towards a more sustainable path)	-	-
Designing products for the circular economy (Circular economy principles at the heart of companies design processes)	-	-

Appendix 7 – Continuation.

Chapter	Quote (and page)	Description (water)
Circular consumption through innovative business models (New circular economy business models can promote more sustainable production and consumption)	-	-
Looping resources (In a circular economy, waste is a resource)	-	-
Resource-efficient production (Resource efficiency and industrial symbioses contribute to the circular economy)	“Increased focus on resource efficiency has resulted in innovative Danish clean-tech solutions and expertise that are exported widely on the global market, such as energy-saving pumps and water-efficient solutions.” (Page 16)	Reference to technological innovations that allow to improve the efficiency of water related activites.
	"At the Yokohama Rubber factory in Japan, Grundfos switched out the main pump delivering water to cool the factory´s production line. This enabled the company to drastically reduce energy costs by more than 50% while also contributing towards its commitment to reduce CO2-emissions." (Page 17)	The introduction of a new pump (therefore an innovation) reduced energy costs and CO2 emissions.
	"Water: 6. Waste water 7. Cleaned waste water 8. Surface water 9. Technical water 10. Used cooling water 11. Deionized water 12. Sea water 13. Drain water 14. Tender water 15. Process water 16. Cleaned surface water" (Page 17)	Reference to the water types exchanged in an industrial symbioses case.
Turning biological side streams into value (Bio-products from agriculture possess a great potential for reciculation)	"Investments in the value chain, such as breeding of animals, new effective stables, feed optimisation, recycling of nutrients, as well as improving energy and water efficiency, logistics and utilisation of side-streams, are interconnected." (Page 19)	Reference to the link between processes and the chain reaction between them, meaning that if one is improved, all benefit from the results.
Building circular (Realising the enormous potential of a circular economy in the built environment)	-	-
Unleashing the potential of circular economy (The circular economy is here to stay - and Danish companies can help accelerate the transition)	"House of Green is an interactive visitors’ and exhibition centre located in the heart of Copenhagen. House of Green uses a combination of guided storytelling and self-exploration to showcase green Danish integrated solutions and scenarios, as well as an overview of the overarching Danish story within energy, climate, water and resources." (Page 23)	Reference to water as an area of focus from the Danish government, among some others.

Appendix 7 – Continuation.

Chapter	Quote (and page)	Description (water)
Unleashing the potential of circular economy (The circular economy is here to stay - and Danish companies can help accelerate the transition)	"State of Green is a public-private partnership founded by the Danish Government, the Confederation of Danish Industry, the Danish Energy Association, the Danish Agriculture & Food Council and the Danish Wind Industry Association. H.R.H. Crown Prince Frederik of Denmark is patron of State of Green. As the official green brand for Denmark, State of Green gathers all leading players in the fields of energy, climate, water, and environment and fosters relations with international stakeholders interested in learning from the Danish experience." (Page 23)	Reference to water as an area of focus for the State of Green partnership.

Appendix 8 - Total water references for the Finnish document on circular economy.

Chapter	Subchapter	Quote (and page)	Description (water)
FOREWORD	-	-	-
ROAD MAP	INTRODUCTION (Towards systemic change)	-	-
	FINLAND'S CIRCULAR ECONOMY TARGET	-	-
	ROAD MAP TO A CIRCULAR ECONOMY (Road map focus areas; Road map actions; Sustainable food system; Forest-based loops; Technical loops; Transport and logistics; Common actions; Operative road map goals; Road map progress and impact assessment; Road map implementation)	"In terms of recycled nutrient use, existing nutrients will be utilised to increase biomass and thus reduce the amount of nutrients entering waterways and causing eutrophication." (Page 15)	Reference to the protection of the waterways by recycling nutrients used for example in agriculture.
		“Promote nutrient recycling from the sea and waterways to the soil by means of, for example, selected fishing that targets the Cyprinadae family and using catches from fish stock management for human consumption and for processed products with higher added value.” (Page 16)	Reference to the extraction of nutrients from aquatic means that are then used in soils.
		"Refining bio-based raw materials into products with a higher refinement value, increasing product biodegradability and recycling and using more environmentally-friendly production methods instead of production processes that consume a lot of water, energy and raw materials all support circular economy targets." (Page 21)	Reference to bio-based raw-materials and their processing, which could be made in ways that increase its biodegradability and recycling, while also using methods that save water.

Appendix 8 – Continuation.

Chapter	Subchapter	Quote (and page)	Description (water)
ROAD MAP	ROAD MAP TO A CIRCULAR ECONOMY (Road map focus areas; Road map actions; Sustainable food system; Forest-based loops; Technical loops; Transport and logistics; Common actions; Operative road map goals; Road map progress and impact assessment; Road map implementation)	“Switching to the use of recycled nutrients in waste water treatment plants at forest industry plants : All of UPM’s waste water treatment plans will commit to using only recycled nutrients instead of mineral nutrients by 2030. ” (Page 21)	Reference to the extraction of nutrients from waste water that are then used to enrich soils.
		"The goal of the Smart & Clean project is to create a lowcarbon and smart transport and mobility export concept for Finland. Over a 5-year period, 20-30 significant project entities will be created, with the themes of transport, construction, energy, waste and water sector and consumer cleantech." (Page 27)	Reference to several areas of interest that can contribute to a low carbon and smart transport and mobility city, with water being one of them.
		“Making water transport in the Saimaa region a resource-efficient alternative to land transport. The goal is to find concrete methods that would make water transport in the Saimaa Canal and Vuoksi waterways a potential alternative to transport by land while still preserving the sensitive lake environment. Increasing the amount of water transport aims at achieving positive impacts (reaching the emissions targets set for transportation), optimising the use of logistics resources in the spirit of the circular economy, raising traffic safety (via reduced road transport), and promoting market functionality (water transport offers a competitive and realistic option). Eliminating bottlenecks can also open up other opportunities. The aim is to increase the number of water transport to and beyond the record level of 2004. Opportunities for growth in the share of water transport can be sought via actions of different types: - business economics: developing line service by means of ”broker” activities (consolidation of smaller cargo loads into larger entities); - digitisation: smart waterway infrastructure (including smart signs and buoys, more detailed and illustrative information about waterways), a digital transportation chain (enables consolidation of cargo loads)” (Page 29)	Reference to the attempt to make water transports as efficient as the land counterparts. That goal includes the reduction of emissions, logistics improvement, better transport safety and more market options.
		"From waste to energy and bioenergy. Mainly developing markets. The goal is to speed up and increase the international growth of companies throughout the industry value chain (raw materials, energy production and biofuels), primarily by means of export. The Finnish offering will cover the entire scope, from small off-grid solutions to large, centralised solutions. The aim is to identify entities and develop joint projects to provide more extensive coverage of the value chain. The increased global need for energy, food and water will spur growth in this sector." (Page 33)	Reference to the relevance of water worldwide and the business opportunity of developing that sector.
BACKGROUND REPORT	INTRODUCTION	-	-

Appendix 8 – Continuation.

Chapter	Subchapter	Quote (and page)	Description (water)
BACKGROUND REPORT	CIRCULAR ECONOMY THROUGHOUT THE WORLD	"A circular economy uses the earth's limited resources (metals, minerals, energy sources, water, timber stocks, rich soil, clean air and biodiversity) in a sustainable manner." (Page 45)	Reference to water as one of the limited resources that would benefit from a circular economy.
	STARTING POINTS FOR THE CIRCULAR ECONOMY IN FINLAND	"Ecological footprint measures the size of the land and water area required to produce the food, materials and energy we consume and process the resulting waste." (Page 47)	-
		"A circular economy makes it possible to reduce resource use (water, soil, materials), greenhouse gas emissions and the need for energy, and thus also support achievement of the UN's sustainable development targets." (Page 49)	Reference to water as one of the resources that would benefit from a circular economy.
	CIRCULAR ECONOMY ROAD MAP: WORK PHASES	-	-
	TOWARD THE TARGET: FINLAND IS A CIRCULAR ECONOMY LEADER IN 2025	-	-
APPENDIX: WORKING GROUP	-	-	-

Appendix 9 - Total spatial planning references for the Finnish document on circular economy.

Chapter	Subchapter	Quote (and page)	Description (S.P.)
FOREWORD	-	-	-
ROAD MAP	INTRODUCTION (Towards systemic change)	-	-
	FINLAND'S CIRCULAR ECONOMY TARGET	-	-

Appendix 9 – Continuation.

Chapter	Subchapter	Quote (and page)	Description (S.P.)
ROAD MAP	ROAD MAP TO A CIRCULAR ECONOMY (Road map focus areas; Road map actions; Sustainable food system; Forest-based loops; Technical loops; Transport and logistics; Common actions; Operative road map goals; Road map progress and impact assessment; Road map implementation)	“Intangible value creation is a key factor in the circular economy, so strong integration and commercialisation of ecosystem services will open up new business opportunities. OpenNESS is a European research project that wants to link the concepts of ecosystem service and natural capital with the planning of land use and natural resource use. The project offers tested, practical and tailored methods for integrating ecosystem services into different sectors. The international project investigates how the concepts link to and support EU policies. It also assesses which factors will enable or prevent the maintenance and continuity of ecosystem services in the future.” (Page 21)	Reference to a European project that attemps to link the concepts of ecosystem service and natural capital with the planning of land use and natural resource use.
		-	-
		"Construction uses a huge amount of materials and masses for different products and surfaces. Choices of materials and products affect a building’s service life and how it can be refurbished. In terms of the circular economy, town planning is the first decisive phase, because it can, for example, be used to steer construction efficiency and material choices. On the other hand, building and project planning can steer material flows at the work site, such as using masses at another work site, using excess material, minimising waste, using any demolition waste, etc. Realisation of this requires town planners, permit authorities, designers, customers and implementers share a commitment to anticipation." (Page 25)	Reference to the way that spatial planning, in particular town planning, can be the first major step towards a better construction and material use efficiency.
		“In the Helsinki area alone, there are currently 1.25 million m2 of empty office space which cannot currently be converted for residential use because of planning regulations. Assuming that a third of this space could be converted by 2030, measured in rental income the value of such a conversion would be around EUR 255 million a year. The national economy would also save close to EUR 700 million if the costs of conversion were compared to the costs of new construction.” (Page 25)	Reference to how spatial planning can have a massive impact in the economy when planned properly.
		“Among others, the following methods can promote the transport change:” “… promoting a transport change by means of land use, transportation and housing agreements (LHT Network); increasing the number of parking places for shared cars by means of flexible town planning and developing the related co-operation;” (Page 26)	Reference to the effect of spatial planning in transport changes.

Appendix 9 – Continuation.

Chapter	Subchapter	Quote (and page)	Description (S.P.)
ROAD MAP	ROAD MAP TO A CIRCULAR ECONOMY (Road map focus areas; Road map actions; Sustainable food system; Forest-based loops; Technical loops; Transport and logistics; Common actions; Operative road map goals; Road map progress and impact assessment; Road map implementation)	"Public procurements can play an important role in promoting the use of sustainable forms of transport. These include sharing concepts, more attractive public transport and Mobility as a Service (MaaS). For example, planning of the Engelinranta district in Hämeenlinna takes robot and shared cars into account as well as the seamless combination of ridesharing and cycling. Shared cars will decrease the need for parking places in the area and a mobile transport point will enable smooth changes from one form of transport to another." (Page 28)	A district planning took transportation in consideration decreasing the need for parking spaces and other benefits.
		"Planning and implementation of a zero-waste pilot. According to its strategy, the city of Turku wants to be carbon-neutral by 2040 and is planning a zero-waste pilot. Even now, landfill waste sorting accounts for only a marginal share of waste management in Turku and the city intends to invest more in exploiting materials and developing energy utilisation in line with circular economy principles. The goal of a zero-waste area is to reduce loss and increase material loop efficiency. The Southwest Finland regional circular economy road map scheduled for completion in late autumn 2016 can be used when planning the pilot. Similar efforts in other regions are also welcome and actions will be supported, for example, via the FISU network." (Page 33)	Spatial planning as a tool to reduce waste and develop energy efficient processes.
BACKGROUND REPORT	INTRODUCTION	-	-
	CIRCULAR ECONOMY THROUGHOUT THE WORLD	-	-
	STARTING POINTS FOR THE CIRCULAR ECONOMY IN FINLAND	-	-
	CIRCULAR ECONOMY ROAD MAP: WORK PHASES	-	-
	TOWARD THE TARGET: FINLAND IS A CIRCULAR ECONOMY LEADER IN 2025	-	-
APPENDIX: WORKING GROUP	-	-	-